The Great Basin Naturalist

VOLUME I

JULY 1939 — JUNE 1940

VASCO M. TANNER, *Editor*

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INTRODUCTORY NOTE

This publication, to be known as The Great Basin Naturalist, will contain in the main the results of investigations dealing with the fauna of the Intermountain States. It has been apparent for some time that such a publication would be of service, as an outlet for the results of research, to the workers at the Brigham Young University, as well as other investigators of this region. It will also help to make more available to students the printed results of studies relating to the natural history of the Rocky Mountain States. For years papers have been published in various periodicals in this country many of which are not accessible to the students of the universities, junior colleges, and to the same extent the museums. The fauna of this region is far from being well known. The natural habitats are fast becoming changed due to grazing of livestock, agricultural activities, forest fires, and floods. Civilization is bound to bring about radical ecological changes, and the extinction of many of the endemic species. Reports upon collections that have been made, and the results of field studies, should be recorded. It will be our policy, therefore, to publish finished research papers, progress reports, and notes dealing with the physiology, morphology, ecology, and taxonomy of the animal and plant life of this region.

Numbers of this publication will be printed as the studies and manuscripts are completed. When the volume has reached a sufficient size, contents and indices will be prepared.

The Great Basin Naturalist will be sent to universities, libraries, and museums. Exchanges of an equal nature are desired and should be sent to *Editor, The Great Basin Naturalist, Brigham Young University, Provo, Utah.*

Vasco M. Tanner, *Editor*

Notes on the Gordiacea of Utah

An interesting record and observation on *Gordius robustus* (Leidy) was made in 1934, by Dr. Fred R. Taylor Jr., physician and surgeon of Provo. Dr. Taylor obtained a specimen of this species from the urine of one of his female patients. He reported the matter to me, and a study of the specimen revealed that it was *G. robustus*. The conditions under which this roundworm lived in the women is not known. Dr. Taylor said there was no doubt that it was passed through the urinary tract.

Gordius robustus is fairly common in Utah; specimens have been collected in Daggett, San Juan, Sanpete, and Utah Counties of Utah.

Paragordius varius (Leidy), a second species of Gordiacea was brought into the laboratory in June, 1939. This species was found in a cricket, *Gryllus assimilis*, by Mr. Howard Feast of Provo. One evening when Mr. Feast was in his garden, he saw a cricket moving slowly and in a groggy manner. He picked it up and placed it in a bottle; when to his surprise, the parasite began to emerge. At this point the specimens were brought to the writer, and both were studied alive. The cricket soon died, and was examined for eggs or embryos, but none were found. This specimen of *P. varius* is 13 inches long, which makes it interesting to think of a worm of this length developing and being coiled in the abdomen of a cricket. The abdomen did not appear to be greatly enlarged. These two species of Gordiacea, *Gordius robustus* Leidy and *Paragordius varius* (Leidy), are new additions to the faunal lists of Utah.—V. M. T.

A STUDY OF THE GENUS SCAPHIOPUS[1]

The Spade-foot Toads

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INTRODUCTION

It is a little more than a hundred years since Holbrook, 1836, erected the genus *Scaphiopus* describing *solitarius,* a species found along the Atlantic Coast, as the type of the genus. This species, however, was described the year prevously, 1835, by Harlan as *Rana holbrookii;* thus *holbrookii* becomes the accepted name of the genotype. Many species and sub-species have been named since this time, the great majority of them, however, have been considered as synonyms. In this study I have recognized the following species: *holbrookii, hurterii, couchii, bombifrons, hammondii, and intermontanus.* A variety of *holbrookii,* described by Garman as *albus,* from Key West, Florida, may be a valid form; but since I have had only a specimen or two for study, I have disregarded any discussion of it.

The study of the Scaphiopodidae made by Professor E. D. Cope (1889) has been followed in the main, since it has been most valuable in dealing with the anatomy of the species. In this study Cope proposed that the Spadefoot Toads of the western United States should be placed in a genus *Spea,* which he characterized as follows: "cranial derm free from cranium; the latter generally with a frontoparietal fontanelle; vomerine teeth present; toes webbed; cuneiform process large." The following two species he assigned to the genus: *hammondii* Baird found in the western United States and *multiplicata* Cope found in the Valley of Mexico. Cope also divided the species *hammondii* into three sub-species: those in North Dakota and Oklahoma, westward into the Rocky Mountains, he called *S. h. bombifrons;* those from Walla Walla, Washington, south through Idaho, Nevada and Utah, he separated off as *S. h. intermontana*; and those along the Pacific Coast, from Washington to Lower Cailfornia and eastward into Texas and Arizona, he considered as *S. h. hammondii.*

(1) Contribution No. 75.

In a number of recent studies[2] [3] [4] [5], the Spadefoot Toads found within the range of "North Dakota and British Columbia to Oklahoma, Texas and Mexico, west to the Pacific Coast States" have been considered as a single species *Scaphiopus hammondii* Baird. In 1934, Hobart Smith proposed the re-establishment of Cope's *bombifrons* as a valid species, giving as its range western Kansas, Harding County; South Dakota; western Oklahoma; northeastern New Mexico, and Bannock County, Idaho. Since Smith proposed the establishment of *bombifrons* as a species, I have been engaged in a study of specimens taken in the intermountain region, especially in Utah. In making this study I have found it impossible to work out the relationships and distributions of the species under discussion without specimens from various parts of United States. Through the kindness of a number of museums and workers, I have been able to study over five hundred specimens.

In studying these specimens, an examination was made of the cranial structures, cutting spades, appendages and body measurements, color and texture of the skin, and distribution. Tadpoles of several species were studied, but since so little material was available, only a brief reference to this study is included here. Much remains to be done in carefully studying the larval stages of the several species.

From my study of the immature forms, I am convinced that a great deal can be learned concerning the range and relationship of the various species through an investigation of this kind.

I found Drs. Wright's,[6] Storer's, and Smith's[7] papers of value in studying the mouth structures of the immature stages.

ACKNOWLEDGMENTS

The writer wishes to thank Mr. Joseph Slevin, Curator of Herpetology at the California Academy of Sciences; Mr. L. M. Klauber, Curator of Herpetology at the San Diego Natural History Museum; Dr. Edward H. Taylor of the University of Kansas; Dr. Leonhard

(2) Storer, Tracy I., 1925. "A Synopsis of the Amphibia of California," pp. 148-62. Univ. of Calif. Publication in Zoology, Vol. 27.

(3) Slevin, Jos. R., 1928. "The Amphibians of Western North America," pp. 84-87. Occasional Papers, California Acad. of Sci., Vol. 16.

(4) Tanner, Vasco M., 1931. "A Synoptical Study of Utah Amphibia." Utah Acad. of Sciences, Vol. 8, pp. 171-173.

(5) Stejneger, Leonhard, and Barbour, Thomas, 1933. "Check List of North American Amphibians and Reptiles," p. 26.

(6) Wright and Wright, 1933. Handbook of Frogs and Toads, pp. 40-41.

(7) Smith, Hobart M., 1934. "The Amphibians of Kansas," pp. 427-36. American Midland Naturalist, Vol. 15, No. 4.

Stejneger of the U. S. National Museum; Mr. Ross Hardy of the Dixie College for the loan of specimens; Dr. M. Graham Netting of the Carnegie Museum at Pittsburg for suggestions; and James Bee and Harry Chandler, graduate students at the Brigham Young University, for aid in making drawings and labeling illustrations used in this study.

THE GENUS SCAPHIOPUS

There seems to be little justification for Cope's separating the western *hammondii* group of species from the eastern *holbrookii* complex for the founding of the genus *Spea*. It is true that the *hammondii* specimens have "derm distinct from cranium, which is usually only ossified superficially in the superciliary bars," but while this difference, as well as others, exists between the two proposed genera, *Scaphiopus* and *Spea*, there are also many similarities which, in my opinion, hold the species under discussion in one genus. I am, therefore, reluctant to accept Professor Cope's proposal of establishing a genus for the western species, but I do believe that it is of advantage in discussing the genus *Scaphiopus*, to divide it into two sub-genera, *Scaphiopus* and *Spea*. Geographically the sub-genera are fairly distinct, having evolved, it would seem, from a common center of origin near northern Mexico, the sub-genus *Scaphiopus* having radiated into the eastern United States, while the sub-genus *Spea* is found in the western United States. These two sub-genera may be separated as follows:

A. Parotoid distinct to indistinct. Head length 18.5 mm to 22.5 mm, width between nasal and orbit greater than 5 mm, width between orbits 5-7.4 mm, frontoparietal interorbital space wide, not modified, and with the skin rather tightly attached to the cranium, spade-like process cycle shaped, long 3.9-5.7mm. Species found in eastern and southern states into Texas. Pl. I, Figs. 1-6; Pl. II, Fig. 3; Pl. III ..... Sub-genus *Scaphiopus*

AA. Parotoid absent. Head length 15.6 mm to 16.5 mm, width between nasal and orbit less than 4 mm, width between the orbits 4 to 4.8 mm, frontoparietal interorbital space narrow, nasal modified by the presence of protuberances or fontanelle or valley without fonta-

nelle. Skin somewhat glandular and loosely attached to the cranium, spade-like process cuneiform, short, 2.9 to 3.5 mm. Species found in the northwestern states into Texas. Pl. I, Figs. 7-12; Pl. II, Fig. 1-2; Pl. III... .....Sub-genus *Spea*

THE SUB-GENUS SCAPHIOPUS

In the sub-genus *Scaphiopus* the frontoparietal and nasal bones are broad without fossae; the head length and distance between the nasals and orbits is greater than in the sub-genus *Spea*. The color and skin texture is different, being brown to greenish with small uniform tubercles on the back and sides, while the *Spea* group has a blackish color on the back and whitish on the sides and venter with irregular placed and variably sized warts on the head, back, and dorsal portions of the legs. Species of this sub-genus are found in the eastern and southeastern states into Mexico.

The three species assigned to the sub-genus *Scaphiopus* are *holbrookii*, *hurterii*, and *couchii*. These species may be separated as follows:

A. Pectoral glands present; parotoid and tympanum distinct.

b. Head length 18.5 mm, width of head 21.5 mm, body length 50.8 mm, between the nasal and orbit 5.2 mm, color brownish to olive green .....*holbrookii*

bb. Head length 22.3 mm, width of head 25.2 mm, body length 66 mm, between nasal and orbit 5.9 mm, frontoparietal area just back of the eyes elevated, glandular, and with roughened minute round warts. Color yellowish green to grey.....*hurterii*

AA. No pectoral glands present; parotoid and tympanum indistinct.

c. Head length 19.7 mm, width of head 23.3 mm, body length 56.3 mm, between nasal and orbits 5.2 mm, frontoparietal area not elevated or rugose. Skin tuberculate on back, color greenish.....*couchii*

DISCUSSION OF THE SPECIES OF SUB-GENUS SCAPHIOPUS

(1) Scaphiopus holbrookii (Harlan). Solitary Spadefoot

Pl. I, Figs. 1-2; Pl. III

Rana holbrookii Harlan, Med. Phys. Researches, 1835, p. 105.
Scaphiopus solitarius Holbrook, N. Am. Herp., 1836, Vol. 1, p. 85, Pl. XII.

Type locality: South Carolina.

Measurements: The following are measurements in millimeters of five specimens of *Scaphiopus holbrookii* obtained by loan from the U. S. Natural Museum. An average of the measurements of the several specimens reported is included. No general description of the species is given since it is believed that the measurements, keys and illustrations are sufficient for the separation and limitation of the species under discussion.

	1	2	3	4	5	Ave.
Total length of body.....	54.0	52.0	54.0	42.5	51.5	50.8
Length of head.....	20.0	20.0	19.5	15.0	18.0	18.5
Width of head.....	22.0	22.0	22.5	18.0	21.0	21.1
Between nasal openings	4.3	3.8	3.5	3.5	3.5	3.7
Between nasal and orbit....	5.5	5.2	5.5	5.0	4.8	5.2
Width of orbit.....	6.5	7.0	7.0	6.5	6.5	6.7
Between orbits	7.0	7.0	7.0	6.5	6.5	6.8
Forearm	13.5	12.0	15.0	11.0	12.0	12.7
Hand	11.0	10.0	11.0	10.0	10.0	10.4
Femur	24.0	20.0	23.0	18.0	19.0	22.8
Tibia	19.0	17.0	19.0	15.0	16.0	17.2
Whole foot	30.0	28.5	32.0	24.0	25.0	27.9
Cutting spade	4.0	4.0	4.2	4.0	3.6	4.0

Number 1, specimen number 3710, collected at Cambridge, Mass.; number 2 and 3, specimen number 71026 and 71025, collected at Gainesville, Fla. by G. S. Miller; number 4, specimen number 31025, collected at Bay St. Louis, Mo. by A. Allison; number 5, specimen number 1673, collected at Pensacola, Fla.

Distribution of specimens studied: Cambridge, Mass.; Bay St. Louis; Miss. (A. Allison); Delair, N. J. (W. P. Seal); Gainesville, Fla.; Houston and Brownsville, Texas.

REMARKS: This distinctive species is widely distributed throughout the eastern United States, but is scarcely met with, because of its secretive nocturnal habits. They breed usually in temporary pools and puddles from March to September. The tadpole stages lasts about 30 days, when the small toads leave the puddles, if they are not already practically dried up, and begin life on the land by hiding during the day in the soil ofttimes far removed from any permanent water.

(2) SCAPHIOPUS HURTERII Strecker. Hurter's Spadefoot

Pl. I, Figs. 3-4; Pl. II, Fig. 3; Pl. III

Scaphiopus hurterii Strecker, Proc. Biol. Soc. Washington, Vol 23, July 23, 1910, p. 116, pl. II, figs. 3-4.

TYPE LOCALITY: Waco, Texas (3½ miles east).

MEASUREMENTS: The following are measurements in millimeters of nine specimens of *Scaphiopus hurterii* obtained by loans from Dr. E. H. Taylor of Kansas State University and Mr. L. M. Klauber of San Diego, California.

	1	2	3	4	5	6	7	8	9	Ave.
Total length of body...	62.5	63.0	68.0	62.0	71.0	69.0	72.0	61.0	71.0	66.0
Length of head.....	20.0	22.0	22.0	22.5	22.0	23.0	24.0	22.5	23.0	22.3
Width of head.....	23.0	25.5	25.0	24.0	25.5	26.5	27.0	25.0	26.0	25.2
Between nasal openings	4.0	5.0	5.0	4.6	5.0	5.0	5.0	5.0	5.0	4.8
Between nasal and orbit	6.0	6.0	5.8	5.8	6.0	6.0	6.0	6.0	5.8	5.9
Width of orbits.....	7.0	7.0	7.0	7.0	7.0	7.0	7.8	7.0	7.6	7.1
Between orbits	6.8	7.0	7.0	7.5	7.0	7.0	8.0	7.0	7.5	7.4
Forearm	16.0	16.0	17.0	16.0	19.0	18.0	18.0	16.0	17.5	17.0
Hand	12.0	13.0	12.0	12.0	13.0	13.0	13.0	13.0	13.0	12.6
Femur	25.6	27.5	29.0	27.0	30.0	28.0	29.0	24.0	28.0	26.4
Tibia	20.0	21.0	23.0	22.0	24.0	24.0	24.5	21.0	22.0	22.4
Whole foot	34.0	32.0	39.0	34.0	39.0	40.0	42.0	34.5	35.0	36.6
Cutting spade	5.0	5.6	6.0	5.6	6.0	6.0	6.0	5.5	6.0	5.7

Number 1, specimen number A125, collected at Benton, Atoscosa Co., Texas, June 5, 1932 by Taylor and Smith; numbers 2-9, specimen numbers 30430, 30432, 30429, 30431, 30434, 30435, 30433, collected seven miles southeast of Lytle, Texas.

Distribution of specimens studied: Benton, Atascosa, Co., Texas, Taylor and Smith; Lytle, Texas. (From L. M. Klauber Collection, San Diego, California.)

Remarks: I am including Strecker's description of *hurterii* in order that it may be compared with the measurements of the specimens reported here. While the average size, especially of the whole foot, femur, forearm, width of head and body length is greater than *holbrookii*, contrary to Strecker's description, I believe this may be due to the fact that I have had a greater number of specimens for use in this study from a different locality to that of Mr. Strecker. I am in agreement with Dr. Hobart Smith that *hurterii* is a distinct form. The elevated rugose post interorbital area seems to be a most distinctive character.

Strecker's description of hurterii follows: "Size medium. Length of head and body, 67 mm. Head short, length about equal to width. (In *holbrookii* the head at angle of jaws is much wider than long.) Snout heavy and blunt, not extending beyond the mouth. Parotoids nearly round, higher and even more conspicuous than in the eastern species. Tympanum distinct but rather smaller than in *holbrookii*. (In type hardly more than half the diameter of the parotoid.) Crown distinctly rugose. No black granules in space between and in front of the eyes. Upper surfaces with small, closely set tubercles very uniform in size and distribution. Many tubercles on sides, buttocks and posterior portion of the abdomen. Many pustules on upper surface of tibia. Glands on thorax present, conspicuous. Enlargements resembling glands on inferior surface of femur (present in both specimens). Spade-like process of foot narrowly margined with black. Palmar tubercles rather small. Fingers slender. Tibia about equal to that of *S. holbrookii* but femur and foot much shorter.

Color above, pale greenish, with a pale yellowish line from each orbit; these converge again on the coccyx. Upper surface of head and area between the light lines, dark plumbeous. Parotoids olive. Sides of head and under surfaces yellowish-white.

The Refugio specimen is slightly smaller. (Length 63 mm) Coloration in life darker. Greenish above, light lines inconspicuous. In form and other important characteristics resembling the type."

(3) Scaphiopus couchii Baird. Couch's Spadefoot

Pl. I, Figs. 5-6; Pl. III

Scaphiopus couchii Baird. Proc. Ac. Nat. Sci. Phila.; Vol. 7, 1854, p. 62.

Type locality: Rio Nasas, Coahuila, and Matamoros, Tamaulipas, Mexico.

Measurements:

	1	2	3	4	5	6	7	8	9	Ave.
Total length of body...	56.0	60.0	60.0	53.0	60.0	58.5	45.5	55.0	58.0	56.2
Length of head.....	20.5	21.0	21.0	20.0	20.5	20.0	15.0	19.5	20.0	19.7
Width of head.....	25.0	25.0	24.0	22.5	24.0	24.0	18.0	22.5	24.0	23.2
Between nasal openings	3.5	3.5	3.2	3.0	3.2	3.5	3.5	3.5	3.5	3.4
Between nasal and orbit	5.3	5.5	5.5	5.5	5.0	5.0	3.5	5.5	5.5	5.1
Width of orbits.....	8.0	8.0	8.0	8.0	8.0	8.0	6.5	7.5	8.0	7.8
Between orbits	5.5	5.5	5.5	5.0	5.0	5.0	4.6	4.5	5.0	5.1
Forearm	17.0	17.0	17.5	13.5	17.0	14.0	11.0	16.5	17.5	15.7
Hand	13.0	12.5	12.0	12.0	13.0	13.0	9.5	12.0	12.5	12.2
Femur	26.0	25.0	26.5	24.0	26.0	26.0	20.0	23.5	25.0	24.7
Tibia	21.0	21.0	21.5	18.5	21.0	20.5	17.0	20.0	20.0	20.0
Whole foot	30.0	32.5	33.0	29.0	33.0	32.5	24.0	31.5	22.5	29.8
Cutting spade	4.0	4.0	4.3	4.0	4.0	4.0	2.8	4.0	4.2	3.9

Numbers 1-3, specimen numbers 47132, 47134, 47130, collected at San Pedro, Lower California, Mexico, July, 1919 by Joseph Slevin; number 4, specimen number 13159, collected at Waco, McLennon Co., Texas; numbers 5-7, specimen numbers 35228, 35231, 35230, collected at Fairbanks, Cochise Co., Texas; number 8, specimen number 17771, collected at San Antonia, Bexer Co., Texas; number 9, specimen number 29348, collected 2 miles north of the San Xavier Mission, Arizona.

Distribution of specimens studied: San Pedro, L. Calif., Mex. (Jos. Slevin); Waco, Texas, (Strecker); San Antonio, Texas; Colonia Dublan, Chihuahua Mex., (D. E. Beck); Fairbanks, Ariz., (Jos. Slevin).

Remarks: *Couchii* is confined to the southwestern states, Lower California, into Mexico. It is next to *hurterii*, the largest Spadefoot in our fauna. The frontoparietal bones are well formed extending well into the nasal area. In color *hurterii* and *couchii* are similar.

Couchii does not have the elevated post interorbital area found in *hurterii*.

THE SUBGENUS SPEA

Throughout the Intermountain States to the Pacific Coast and south into Texas and Mexico is a division of toads closely related in external and skull characters. These are here considered under the subgenus *Spea*. The general facies of this subgenus is such that it is easily separated from the eastern *Scaphiopus* group. The head is much shorter; the width between the nasal opening and the orbit is noticeably less; also the interorbital width is less, being modified as in *bombifrons* and *intermontanus*. Pl. I, Figs. 9-12. Other distinctive characteristics are the presence of a fontanelle or a modified one, with the frontoparietal as well as the temporal bones greatly modified; also a cuneform spade-like process, in contrast to the cycle-shaped spade found in subgenus *Scaphiopus*.

While the distribution of these two subgenera is poorly known at present, the only overlapping of the two appears to be in Texas.

Three species are included in the subgenus *Spea;* these may be separated as follows:

A. Presence of an interorbital boss.

b. Head width narrow—18.5 mm.

c. Body smooth with few individual tubercles or warts. Cutting spade narrow and long; hand, femur, tibia, and whole foot short; color grayish above; whitish on venter. In preservative the specimens are an olive green..... *bombifrons*

AA. No interorbital boss present. (In some specimens of *intermontanus* there is a glandular interorbital elevation which resembles the true boss found in *bombifrons*. This may be removed and the true nature of the skull revealed. Pl. I, Figs. 9-12 show this difference.

bb. Head width wider 20.9-22.5 mm.

cc. Body rugose or with many individual prominences or warts. Color mottled

whitish and black above; venter whitish; in preservative the back becomes blackish with some white areas. At times the back is streaked with whitish lines. Venter white.

d. No frontoparietal fontanelle; interorbital space with prominent frontoparietal bones forming ridges as in Pl. I, Figs. 9-10 or in some specimens the interorbital space is filled with a glandular prominence resembling the *bombifrons* species; head width 22.5 mm, whole foot 31.2, confined in the main to the Great Basin area ..... *intermontanus*

dd. A frontoparietal fontanelle present; interorbital space smooth; size intermediate between *bombifrons* and *intermontanus;* head width 20.9; whole foot 28.8; found on the Pacific Coast south into Arizona and Texas..... *hammondii*

(4) Scaphiopus bombifrons (Cope). Central Plains Spadefoot Toad

Pl. I, Figs. 11-12; Pl. III

Scaphiopus bombifrons Cope. Proc. Ac. Phila. 1863, p. 53.
Spea hammondii bombifrons (Cope). Bull. U. S. Nat'l Mus. No. 34, 1889.
Scaphiopus bombifrons Cope. Smith, Am. Midl. Nat., Vol. XV, No. 4, 1939, p. 427.

Type locality: Fort Union on Missouri River, Lat. 48 degrees N.

Measurements: The following measurements were made possible through loans from Dr. E. H. Taylor of the Kansas University and Mr. Joseph Slevin of the California Academy of Sciences, San Francisco.

	1	2	3	4	5	6	7	8	9	Ave.
Total length of body...	48.0	45.5	45.0	50.0	51.5	50.0	50.0	53.0	47.0	48.9
Length of head.....	15.0	15.5	14.5	16.0	16.5	16.0	15.0	16.5	15.0	15.6
Width of head.....	17.0	170.	16.0	20.0	20.0	19.5	20.0	20.0	19.5	18.8
Between nasal openings	5.0	4.0	4.0	4.5	4.5	4.5	4.5	5.0	4.5	4.5
Between nasal and orbit	3.0	3.0	3.0	3.0	3.5	3.0	3.5	3.5	3.5	3.2
Width of orbits.....	6.0	6.0	5.8	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Between orbits	5.0	4.5	4.2	5.0	5.0	5.0	5.0	5.3	4.2	4.8
Forearm	11.0	11.0	10.0	13.0	13.0	13.0	11.5	13.0	12.0	11.9
Hand	10.0	8.5	8.5	10.0	10.5	10.0	10.0	11.0	10.0	9.8
Femur	22.0	21.0	20.5	23.0	23.2	24.0	23.5	23.0	24.0	22.7
Tibia	17.5	16.0	16.0	18.5	19.0	19.0	18.5	20.0	18.0	18.0
Whole foot	16.0	23.0	23.0	28.0	27.5	28.0	27.5	28.5	27.0	25.4
Cutting spade	3.0	2.5	2.5	3.0	3.0	3.0	3.0	3.5	3.0	2.9

Numbers 1-3, specimen numbers 33118, 33117, 33119, collected at Goodnight, Texas, June, 1910 by Strecker; numbers 4-5, specimen numbers A100, A101, collected at 2 miles north of Lexington, Okla., June 3, 1932 by Taylor and Smith; Nos. 6-9, specimen numbers A131, 1632, 1633, 1634, collected 6 miles north of Elkhart, Morton Co., Kan., August 15, 1926 by E. H. Taylor and T. White.

REMARKS: All specimens of *bombifrons* have an interorbital boss which, upon the dissection of the head, is composed in the main of a bony structure in contrast to the glandular structure found in some specimens of *intermontanus*. Just what relationship exists between these two species is not clear.

Reference to Plate III shows the distribution of the specimens actually studied at the time of this writing. Just how the species of *Spea* are distributed in Colorado, Wyoming, and Montana is not known because of lack of specimens from these states. Spadefoot toads taken in the intermountain states are not common in collections.

(5) SCAPHIOPUS INTERMONTANUS (Cope). Great Basin Spadefoot Toad

Pl. I, Figs. 9-10; Pl. II, Fig. 2; Pl. III

Spea hammondii intermontana Cope. Proc. Ac. Phila., 1883, p. 14.

TYPE LOCALITY: Salt Lake City, Utah.

MEASUREMENTS: The specimens reported here are all from the southeastern part of Utah, while specimens collected by Dr. H. C.

Yarrow at Provo, Utah; Capt. C. Bendire at Fort Walla Walla, Washington, and V. Bailey and J. O. Snyder at Pyramid Lake, Nevada have been studied; due to lack of space their measurements are not reported.

	1	2	3	4	5	6	7	8	9	Ave.
Total length of body...	51.5	55.0	56.0	51.0	55.0	63.0	53.0	59.0	53.0	55.2
Length of head.....	16.5	18.5	17.0	17.0	19.0	19.0	17.0	18.0	17.0	17.7
Width of head.....	22.0	23.5	22.5	23.0	24.0	26.0	21.0	23.5	23.0	23.2
Between nasal openings	4.5	4.5	4.5	4.7	5.5	5.0	4.0	4.5	4.8	4.7
Between nasal and orbit	3.0	3.5	3.5	3.5	4.0	3.5	4.0	3.5	3.0	3.5
Width or orbits.....	7.5	7.5	7.0	7.0	7.0	7.5	7.0	7.5	6.5	7.2
Between orbits	4.5	4.8	4.5	5.3	5.0	5.0	4.5	5.0	5.0	4.8
Forearm	14.0	16.0	15.0	14.0	15.0	15.0	12.5	14.0	14.0	14.4
Hand	12.0	14.0	12.0	12.0	12.0	13.0	12.5	12.0	12.0	12.4
Femur	26.0	29.0	26.0	24.0	26.0	29.0	24.0	27.0	27.5	26.5
Tibia	20.0	23.5	21.0	21.0	21.5	21.5	18.0	21.0	22.0	21.0
Whole foot	33.5	36.0	30.0	32.0	31.0	35.0	29.0	32.5	31.0	32.2
Cutting spade	4.0	4.0	3.9	4.0	4.0	4.0	3.0	4.0	3.5	3.8

Number 1, specimen number 50, collected at Garfield County, Utah, June 29, 1938 by Vasco M. Tanner and D. E. Beck; number 2 and 3, specimens numbers 55 and 799, collected at Willow Spring Tank, Kane County, Utah, June, 1936 by Vasco M. Tanner and James Bee; number 4, specimen number 545, collected at mouth of Brush Creek, Uintah County, Utah, July, 1937 by James Bee; number 5, specimen number 46, collected 10 miles south of Gandy, Utah, June, 1928 by Vasco M. Tanner and W. P. Cottam; number 6, specimen number 1980, collected at Orderville, Kane County, Utah, August 4, 1938 by La Voy Esplin; number 7, specimen number 781, collected at Zion National Park, Utah, July, 1925 by Vasco M. Tanner; number 8, specimen number 1977, collected at Steep Creek Lakes, Boulder Mt., Garfield County, Utah, 6500 ft. elevation, June 29, 1938 by W. W. Tanner; number 9, specimen number 8686, collected at Price, Carbon County, Utah, June, 1937 by Ross Hardy.

DISTRIBUTION OF SPECIMENS STUDIED: ARIZONA: Jacobs Lake, Kaibab Forest, July, 1927, V. M. Tanner. IDAHO: Boise, Ada County, July 19, 1917, Richard Erwin. NEVADA: Pyramid Lake, June 14, 1889, C. A. Keeler; June 26, 1893, V. Bailey; Joseph Slevin, July 4, 1916; The Willows, New Pyramid Lake, J. O. Snyder; Mesquite, V. M. Tanner. UTAH, Utah County: Provo, H. C. Yarrow, Payson, V. M. Tanner. Millard County: Gandy, June, 1928, V. M.

Tanner. Kane County: Orderville, July, 1937, Aug. 4, 1938, Truman Swallow and La Voy Esplin; Willow Spring Tank, June, 1936, V. M. Tanner and James Bee; Alton, L. M. Klauber. Washington County: Zion National Park, July, 1925, 1928, 1933, V. M. Tanner; Zion National Park and Toquerville, L. M. Klauber; St. George and Washington, V. M. Tanner. Garfield County: Posy Lake, Aquarious Plateau, June, 1936, V. M. Tanner; Escalante, June, 1936, 1938, V. M. Tanner, W. W. Tanner, and D. E. Beck; Steep Creek, Boulder Mountain, June 29, 1938, W. W. Tanner, D. E. Beck, and Geo. Cannon; Bryce Canyon National Park, July, 1927, V. M. Tanner. Emery County: North of Green River, L. M. Klauber; Green River City, June, 1927, Clarence Cottam. San Juan County: Caroline Natural Bridge, June, 1927, V. M. Tanner, Anson Call, and D. I. Rasmussen. Carbon County: Price, June, 1937, Ross Hardy; Helper and Price, June 16, 1939, V. M. Tanner, W. W. Tanner, James Bee and Grant Harris; Price, October, 1938, Horace Richards. Uintah County: Mouth of Brush Creek, July, 1937, James Bee. WASHINGTON: Ft. Walla Walla, C. Bendire.

REMARKS: The evolution of the subgenus *Spea* seems to be from *hammondii* through *bombifrons* to *intermontanus*. In these species there is a progressive development of the osseous parts of the cranium with a closure of the frontoparietal fontanelle in practically all specimens of *intermontanus*. *Intermontanus* is a large fairly rugose species capable of breeding under desert conditions in the brackish waters of the Great Basin and High Plateaus. This species is common in the southeastern part of Utah. More than a hundred specimens have been collected around Price and Helper, Carbon County and the Escalante Desert in Garfield County. Breeding specimens were taken in June along the Price and Escalante Rivers. They also leave these streams and are found from twenty to fifty miles out in the deserts, congregated around intermittent spring seeps. Great numbers in copula were observed at a small playa in Steep Creek, Boulder Mountain, Garfield County, on June 29, 1938 by D. E. Beck, W. W. Tanner, Geo. Cannon and James Bee. The playa developed after a rain storm which occurred on the night of June 27. No specimens were observed until after the storm, when they seem to come into this temporary pond literally by the hundreds. Breeding commenced at once, the males holding on to the females even after they were collected and placed in cages at camp. On June 20, 1936 tadpoles of various sizes were taken at Willow Spring Tank 50 miles south of Escalante. In a few

specimens the hind legs had started to emerge. Tadpoles were collected in the Price City Reservoir, number 3, on June 16, 1939, by the writer. Many of these were developing their hind legs at this date.

A DESCRIPTION OF THE LARVAE OF INTERMONTANUS: An examination of tadpoles from the above mentioned localities shows a labial disk surrounded by a continuous row of papillae, except for a slight interruption at the upper margin where there is a row of teeth on the disk about 6 mm long. In some specimens there is evidence of two rows in some parts of the disk. The labial teeth are in 2-4 rows; the top row is continuous extending to the corners of the mouth; the second row extends from the corners of the mouth along the first row to about one-fourth its length; the third and fourth rows are short; the fifth and sixth rows are continuous across the lower portion of the mouth. The fifth row is three times as long as one of the parts of the fourth row. The upper mandible has a median point with lateral edges serrate; lower mandible is about the same width as the upper one, with a median notch, but without the projection on the sides, the sides serrate and smoothly rounded off and extending to the angles of the mouth. The mouth structures differ from drawings by Drs. Smith, Storer and Wright. The tadpoles here reported more closely resemble *hammondii* than *bombifrons* judged by the drawing of the above mentioned workers. The mouth is 4.2 mm across, the interorbital space is 3.5 mm, the distance from the mouth to the nasals is 3.5 mm; while it is 1.7 mm from the nasals to the orbits. The body length of tadpoles, with the hind legs showing, is 23 mm; tail length 28 mm. In the water the larvae have a coppery color; while in alcohol preservative they are a bluish black color.

Intermontanus has a greater internarial distance than either *bombifrons* or *hammondii;* the average for 84 specimens is 4.6 mm. The femur and whole foot are both larger in *intermontanus.* I have been unable to use the tympanum and corneous tips of the toes in this study. These characters are variable and in some specimens the corneous tip of the toes is not present.

(6) SCAPHIOPUS HAMMONDII Baird. Hammond's Spadefoot Toad

Pl. I, Figs. 7 and 8; Pl. II, Fig. 1; Pl. III

Scaphiopus hammondii Baird, Rept. Expl. Surv., IV, Reptil., 1859, Pl. fig. 2.

TYPE LOCALITY: Fort Reading, California.

MEASUREMENTS: The following nine specimens are chosen for report from a rather large collection loaned by Mr. L. M. Klauber of San Diego and Mr. Jos. Slevin of the California Academy of Sciences.

	1	2	3	4	5	6	7	8	9	Ave.
Total length of body...	47.0	48.0	46.0	56.0	49.0	54.0	61.5	60.0	55.0	52.9
Length of head.....	15.0	15.0	15.0	19.0	15.0	17.0	19.0	19.0	17.0	17.0
Width of head.....	19.0	19.0	18.0	23.5	19.0	21.0	24.0	25.0	22.0	21.2
Between nasal openings	4.0	4.0	4.0	4.0	3.5	4.0	4.5	4.5	4.0	4.0
Between nasal and orbit	3.5	3.5	3.5	4.5	3.8	4.0	4.5	4.5	4.5	4.0
Width of orbits.....	5.7	5.8	5.5	7.5	6.0	7.0	7.5	7.5	7.0	6.6
Between orbits	4.0	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	4.7
Forearm	12.0	12.0	11.0	14.0	11.0	14.5	14.0	15.0	13.0	12.9
Hand	11.0	11.0	10.0	12.0	10.0	12.0	12.0	12.0	11.5	11.3
Femur	21.0	23.0	21.0	23.0	19.0	25.0	26.0	25.0	23.0	22.9
Tibia	17.5	18.0	17.0	21.0	17.5	20.0	21.0	21.0	20.0	19.2
Whole foot	23.0	26.5	25.0	30.0	26.0	29.0	32.0	31.0	27.5	27.8
Cutting spade	3.0	3.0	3.0	3.5	3.0	3.5	4.0	3.6	3.5	3.3

Number 1 and 2, specimens number 10235 and 10238, collected at Cochise County, Arizona, July, 1928; number 3, specimen number 10296, collected at Brewster County, Texas, July 22, 1930; number 4, specimen number 62922, collected 5 miles north of Bonsell, California, May 24, 1927; number 5, specimen number 7131, collected at San Jacinto, Riverside County, California by L. M. Klauber; number 6 and 7, specimens number 23359 and 240, collected at San Diego, California by L. M. Klauber; number 8, specimen number 23461, collected at Ojos Negros, Lower California by L. M. Klauber; number 9, specimen number 27145, collected at Punta Bunda, Lower California by L. M. Klauber.

DISTRIBUTION OF SPECIMENS STUDIED: ARIZONA: Cochise County, July, 1928. CALIFORNIA: 3 miles N. of Bonsell, May 14, 1927; San Jacinto, Riverside County, L. M. Klauber; San Diego, L. M. Klauber; Berkeley, July, 1938, Tracy Storer. COLORADO: Oxford, La Plata County, Sept. 7, 1920, Ivan M. Way. MEXICO: Ojos Negros, and Punta Bunda, Lower California, L. M. Klauber. TEXAS: Brewster County, July 22, 1930.

REMARKS: Specimens of *hammondii* have shorter, narrower heads, with less internarial space, shorter forearm, femur, and whole foot

than *intermontanus*. The interorbital space is smooth, not possessing ridges or a boss as in *intermontanus* and *bombifrons*. The fontanelle is well developed. Specimens are not as worty as *intermontanus*.

SUMMARY

An examination was made of the cranial structures, cutting spades, measurements of the appendages and body, color and texture of the skin and distribution of specimens of *Scaphiopus* from various parts of the United States and northern Mexico. This study supports the conclusion that the genus *Scaphiopus* may be divided, to advantage, into the subgenera *Scaphiopus* and *Spea;* also that the following: *holbrookii, hurterii, couchii, bombifrons, intermonutanus, and hammondii* should be recognized as valid species.

The cranial structure, body size and markings, and larval characteristics seem to support the proposal, made here, that we separate the Utah and northern Great Basin Spadefoot Toads from the Pacific Coast and Central Plains species, establishing *intermontanus* Cope as a species.

A distributional study of *Scaphiopus* in the states west of the Mississippi River should add much to our knowledge of the range of the subgenus *Spea* here discussed.

Hurterii also seems to be a valid species.

Tadpoles of the various species should be collected and studied.

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EXPLANATION OF PLATES

PLATE I

Figures 1, 3, 5, 7, 9, and 11 are drawings showing the dorsal skull structures of the six species of Spadefoot Toads discussed in this study.

Figures 2, 4, 6, 8, 10, and 12 are drawings of the cutting spades of the six species of Spadefoot Toads under discussion.

PLATE II

Figures 1, 2, and 3 show the distinctive head and interorbital characteristics of *S. hammondii*, *S. intermontanus*, and *S. hurterii*.

PLATE III

The distributional map shows the areas in the United States where the six species of *Scaphiopus*, as here discussed, are found. The map has been made from a study of the specimens available during the progress of this report. Records from the literature have not been used.

STUDY OF GENUS SCAPHIOPUS

VASCO M. TANNER

FIG. 1

SCAPHIOPUS HOLBROOKII

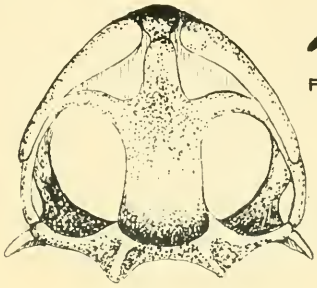


FIG. 3

SCAPHIOPUS HURTERII

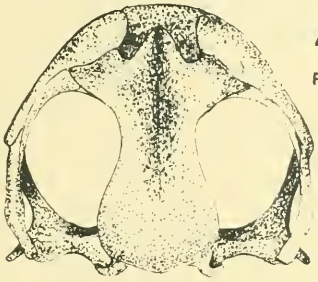


FIG. 5

SCAPHIOPUS COUCHII

FIG. 7

SCAPHIOPUS HAMMONDII

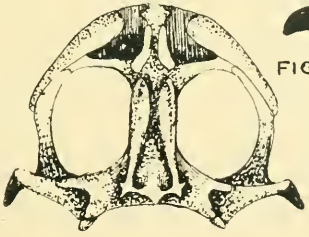


FIG. 9

SCAPHIOPUS INTERMONTANUS

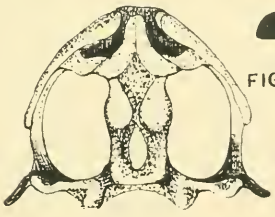


FIG. 11

SCAPHIOPUS BOMBIFRONS

Plate I

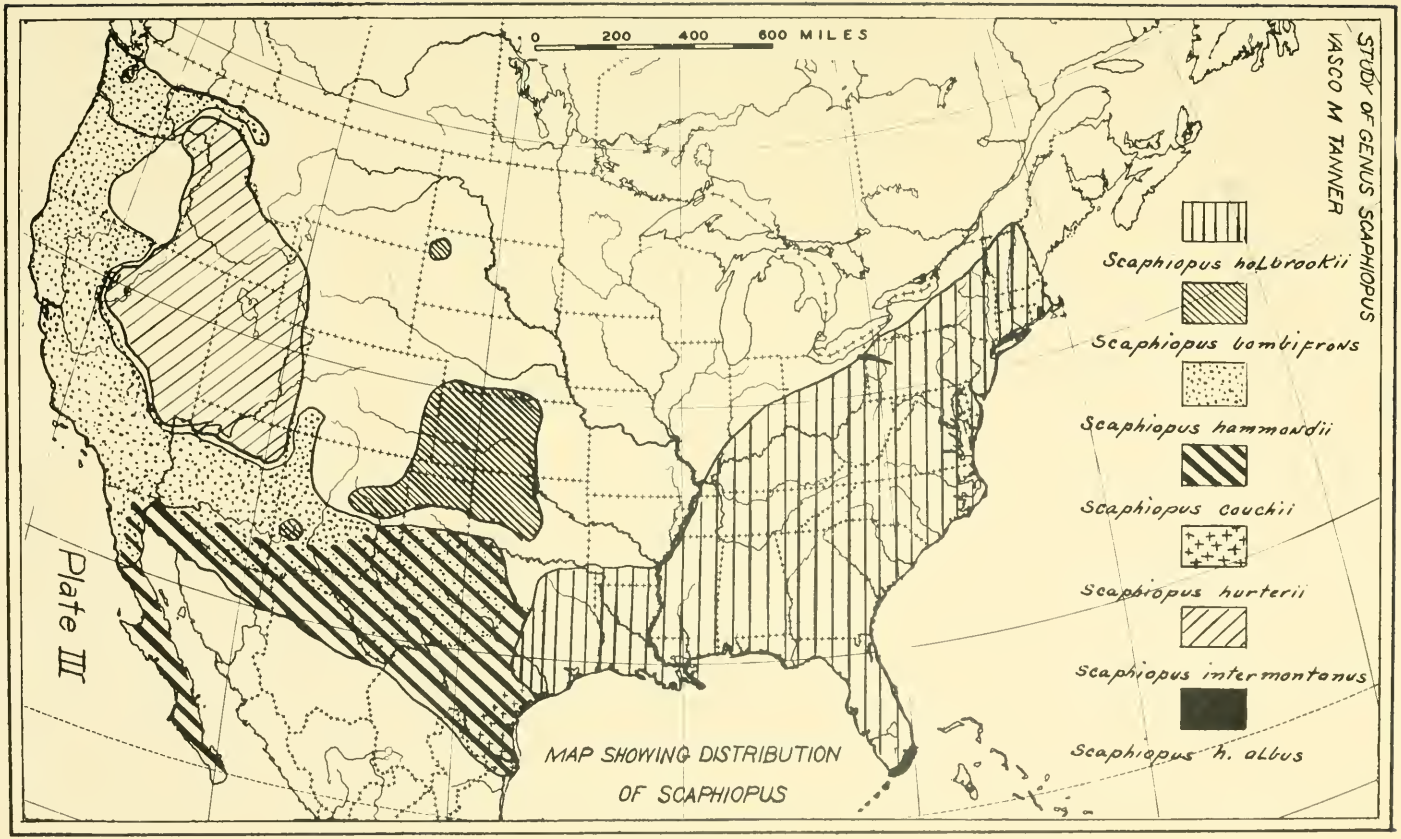
STUDY OF GENUS SCAPHIOPUS
VASCO M. TANNER

FIG. 1
SCAPHIOPUS HAMMONDII

FIG. 2
SCAPHIOPUS INTERMONTANUS

FIG. 3
SCAPHIOPUS HURTERII

Plate II


0 200 400 600 MILES
STUDY OF GENUS SCAPHIOPUS
VASCO M TANNER
Scaphiopus holbrookii
Scaphiopus bombifrons
Scaphiopus hammondii
Scaphiopus couchii
Scaphiopus hurterii
Scaphiopus intermontanus
Scaphiopus h. albus
Plate III
MAP SHOWING DISTRIBUTION
OF SCAPHIOPUS

NOTES ON CHARINA BOTTAE IN UTAH: REPRODUCTION[1]

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and

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DISTRIBUTION

The following notes are based upon specimens of the Rubber Boa, collected in Utah, now in the herpetological collection at the Brigham Young University.

A number of specimens have been added to the collection since the publication in 1933, by the senior author, of a "Study of the Variation of the Dorsal Scale Rows in *Charina bottae*."[2] This species is not easily collected, being secretive in its habits. It seems to move about during the twilight and early morning hours, then resting in some cool place, probably in the grass or in the leaf mould during the day. All the specimens we have collected have been taken during the hours mentioned above.

Thirty-three specimens have been collected in Utah County: twenty-two at Aspen Grove, Mount Timpanogos; seven in Provo Canyon; two in Payson Canyon; one in Rock Canyon, and one in American Fork Canyon.

At the annual meeting of the Utah Academy of Sciences, Arts, and Letters, held at Salt Lake City, in May, 1939, Mr. Ross Hardy reported the occurrence of the Rubber Snake in Carbon County. On June 15, 1939, the writers, while on a collecting trip to Carbon and Emery Counties, talked with Mr. Stanley Nelson, caretaker of the Peerless Mine, the place where the specimen was collected. Mr. Nelson reported that his son collected the specimen on a hay stack. We examined the area and found the hay had been stacked on a shed which was built on a hill-side on which there was a thick growth

(1) Contribution No. 76.

(2) Tanner, Vasco M., 1933. A Study of the Variation of the Dorsal Scale Rows of *Charina bottae* (Blainville). Copeia, July 20, 1933, No. 2, pp. 81-84.

of oaks and other low shrubs. Mr. Nelson also reported having seen another specimen of *Charina bottae* along a small stream, just off the main highway in Price Canyon, about two miles above the Peerless Mine. The range of this snake in Utah is greatly extended, by this record from the High Plateaus and the two records from Payson Canyon, which is only a short distance from the most southern part of the Wasatch Range.

FOOD HABITS

A number of specimens have been kept in the laboratory for periods of one to six months. In a number of cases, captive specimens have eaten small mammals. A nest of *Microtus p. modestus* consisting of four young were eaten; also three young *Peromyscus* sp. The snakes would not take the young rodents outside of the nest, but would enter the nest and there feed upon thier prey. Several specimens, when captured, regurgitated their last meal which consisted of young rodents. In June, 1939, Mr. Ronald Dykes of the C. C. C. Camp in Payson Canyon collected a Two-headed Snake. While he was holding the specimen by the tail, with the head downward, three small "mice" were regurgitated. We have made attempts to have *Charina bottae* feed upon other animals such as insects, cold blooded vertebrates and small birds, but have never been successful. According to Cope (1900)[3] and Van Denburgh (1922)[4], this species has been known to eat lizards of the genus *Sceloporus*. Our information concerning the food habits of adult *Charina bottae* to date supports the belief that their food consists mainly of mammals.

REPRODUCTION

An interesting phase of the life history of the Rubber Snake was brought to our attention last summer (1938) when a specimen, number 690, collected at Aspen Grove in August, gave birth to three snakes on September 9. The fact that the young were born alive so late in the season prompted us to examine all the females in the collection. We were rewarded by finding four specimens with eggs in various stages of development. Since the only reference in the literature to reproduction in this species, we have been able to find, is one by Van Denburgh (1922, Vol. 2, p. 642), we are presenting our findings in the

(3) Cope, E. D., 1900. The Crocodilians, Lizards, and Snakes of North America, Ann. Rept. U. S. Nat. Mus. for the year 1898, pp. 153-1294.

(4) Van Denburgh, John, 1922. The Reptiles of Western North America. Vol. 2, pp. 617-1028.

belief that they may be of some interest. Dr. Van Denburgh has but one sentence on the subject as follows: "A female caught in June contained large eggs."

A large specimen, number 842, measuring 556 mm in length, collected at Aspen Grove on July 30, 1926, contained five eggs. The eggs were in a membranous sac 215 mm long, while each egg was surrounded by a thin sac or shell. The anterior egg measured 45 mm in length and 15 mm wide, while the posterior one measured 44 mm by 14 mm wide. The three in between were similar in size. Each egg had reached about the same embryological development. The embryo, in all cases, was developing on the ventral central part of the egg. The two ends and dorsal portions of each egg were composed of a brownish granular food material. The embryos were removed from the anterior and posterior eggs. The anterior one was 96 mm long, with a head diameter of 4 mm, while the posterior one was 99 mm long, with a head diameter of 4 mm and a body width at about the middle of 3.5 mm. The dorsal scales were developed along the sides but they had not formed along the dorsal midline. The specimen in the anterior egg possessed sixteen rows of scales on one side and seventeen on the other, while the posterior one had twelve rows on each side.

Another specimen, number 676, collected in Rock Canyon east of Provo on August 17, 1938, contained only two eggs. The anterior egg, however, was much larger than eggs in other specimens study. It was 77 mm long and 9.5 mm in width. A small embryo was developing in the center of this egg; blood vessels could be seen scattered through the food material which surrounded the embryo. The posterior egg was small and undeveloped suggesting that it was not fertile.

A specimen, number 1387, was collected at Aspen Grove on July 29, 1935, which measured 629 mm. This female contained eight eggs, the greatest number found in any one specimen. None of the eggs showed any embryonic development. The anterior egg measured 23 mm in length and 10.5 mm in width, while the posterior one was 28 mm long and 12 mm wide.

The largest specimen of this species in our collection, number 674, was collected at Aspen Grove on August 4, 1938, and contained three eggs. None of the eggs had undergone any apparent embryological development. The total length of the three eggs before being disturbed was 119 mm. The anterior egg was 39 mm long and 14 mm

in width. The next one was 43 mm long and 17 mm in width, while the last egg was 37 mm long and 18 mm in width.

A fifth specimen, number 690, taken on August 9, at Aspen Grove, was kept alive in a breeding cage for food study purposes. Fresh grass was placed in the cage three times a week, and insects placed in the cage. On September 9, while removing the dry grass, three small snakes and an undeveloped egg were observed in the cage. The young snakes were dead, probably due to the dryness of the soil and grass. The specimens were removed and preserved. The largest specimen of the three measured 170 mm long, with a head width of 6.1 mm and a dorsal scale count of 42 scales.

It is interesting, at this point, to record the capture of a young Rubber Snake at Vivian Park in Provo Canyon on June 27, 1939. It is 175 mm long, with a head width of 6.2 mm and a dorsal scale count of 41. The color is a reddish-brown similar to the young snakes born in captivity to specimen number 690.

From our findings, it appears that *C. bottae* in Utah gives birth to her young in the fall of the year, or in some cases where development commences late in the year as in number 1387, in the early spring. It would seem that this is the case or else the young produced in the fall grow but very little, if any, before winter hibernation. Just what the young snakes feed upon is also unknown. Because of their size, we surmise that their food must be other than mammalian.

STUDIES IN THE WEEVILS OF THE WESTERN UNITED STATES, NO. III: NEW SPECIES FROM UTAH[1]

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Brigham Young University

EUPAGODERES UTAHENSIS Tanner, new species

Body oblong oval, moderately robust. Rostrum with deep transverse impression at base, median sulcus sharply defined, with distinct foveae near the anterior and posterior ends. Lateral sulci deep, rather long, converging behind until they meet the median sulcus at the transverse impression, surface covered with bluish and lead black scales; the front smooth with no trace of punctures. The scrobes deep and extending obliquely below the eyes; the first joint of the funicle twice as long and a third wider than the second joint. The anterior end of beak as wide, 2 mm, as it is long from the transverse impression to the end. Prothorax cylindrical, sides slightly arcuate, apex and base truncate ¼ wider than long. Median line indistinctly impressed, disk with rather deep closely set evenly distributed punctures, surface lead black except for a triangular spot on each side of the median line, and lateral vittae which are pale bluish scales. Elytra oval, broadest behind the middle, 3 1/3 times as long as the prothorax; more than ½ as wide as long; striae fine, feebly punctured, intervals flat, setae very sparse and minute; surface with bluish and lead black scales with alternate intervals darker, giving a definite vittate appearance. Legs and under surface plumbeous, tibiae not denticulate within. Length prothorax to apex of elytra, male 7.5 mm; female 9.5 mm.

TYPE LOCALITY: St. George, Washington County, Utah. Two specimens, male and female, holotype and allotype, taken in copula by the writer in June, 1929, now in the writer's collection at Brigham Young University.

Utahensis belongs between *geminatus* Horn and *varius* Lec. It may be distinguished from *geminatus* by the fovaelate medium sulcus which joins two deep lateral sulci at the distinct transverse impression; also by the shape and color of the prothorax, in *geminatus* the prothorax is widest at the base and "clothed with whitish scales with a broad plumbeous stripe on each side." In *varius* the medium sulcus of the beak is broad and vague and the thorax and the elytra are not vittate. The general facies of *utahensis* serves to distinguish it from any other described species of this genus.

EUPAGODERES HARDYI Tanner, new species

Form oval, elongate. Rostrum with transverse impression, the median sulcus distinct but not deeply impressed, lateral sulci practically obsolete. The beak 1.5 times as long as wide, being only 1 mm wide. The scrobes are shallow and narrow; the first joint of the funicle twice as long as the second one; the front

(1) Contribution No. 77.

and beak finely punctured. Thorax cylindrical, widest at the middle, deeply punctured on the top and sides and covered with small chocolate brown scales throughout without setae. The elytra wider just back of the middle, being 3.3 mm. wide and 5.2 mm long. The striae are distinct, with definite punctures, intervals slightly convex with decumbent short brown setae; covering small brown and plumbeous scales without any pattern. The color of the body, legs and antennae is dark brownish. Total length of the body from prothorax to tip of elytra 7.1 mm.

Type locality: North Fork of Provo Canyon, Utah County, Utah, elevation 6300 feet. Collected by D. Elmo Hardy. Type in the writer's collection at Brigham Young University.

Hardyi is closely related to *geminatus* but its elongate form, brownish solid color of the body, head and legs, the distinct striae and slightly convex intervals separates it from other species of this genus.

Dorytomus rubidus Tanner, new species

Oblong, flat above, sides parallel, integument rufo-testaceous throughout, vestiture, fine and whitish in color not obscuring the punctures of the thorax and intervals of the elytra, longer on the legs and venter where it arises from the conspicuous punctures. Head and beak with deep close punctures from which arise decumbent whitish setae; short channel between the eyes, beak carinate on upper third, glabrous on anterior third, beak 1 mm long; scrobes from anterior fourth to beneath the eyes, first article of the funicle as long as the second and third combined, front deeply punctured. Prothorax 1 1/3 wider than long, sides practically parallel, slightly rounded at the base, no distinct constriction at the apex, unformally and deeply punctured. Elytra 1/2 wider at the base than the thorax, sides parallel 2.2 mm long; intervals rounded, separated by deep close set punctures, intervals as wide as the punctures, small white setae arise in the punctures and slightly subdue the shining red surface of the integument; beneath deeply punctured, each puncture with a short white decumbent setae, the legs deeply punctured, but with longer setae; tooth on anterior femora distinctive, length 3 mm.

Type locality: St. George, Washington County, Utah. Holotype in the writer's collection at Brigham Young University.

Rubidus according to Col. Casey's key runs to *squamosus* Lec. but is easily distinguished from this species by its distinctive prothorax. In *rubidus* there is no distinct constriction at the apex and the sides are parallel; also the sides and dorsum are deeply punctured but sparsely covered with setae; *squamosus* is constricted at the apex, not so deeply punctured, being covered with squamiform setae. In *rubidus* the first joint of the funicle is shorter than in *squamosus*. *Rubidus* is much more deeply and closely punctured on the entire body than the specimens of *squamosus* from Kansas and Colorado, that are before me.

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C. Lynn Hayward, *Assistant Editor*

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A CHAPTER ON THE NATURAL HISTORY OF THE GREAT BASIN, 1800 TO 1855 (1)

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INTRODUCTION

This paper deals with the early natural history of the Great Basin up to and including the year 1855. This, the largest desert area of our country, 210,000 square miles, is small when compared with the interior basins of other countries. The central desert area of Australia is seven times greater than the Great Basin, while the Sahara is sixteen times larger, and the interior of Asia is twenty-three times its size. Since this interior province is characterized by an arid climate, a closed drainage system, and old remnant mountain systems, surrounded by desert plains, it is a rather natural and unique area with which to deal biologically. In attempting to study various phases of the natural history of Utah, I have found it very helpful, in laying a foundation and providing a background for such a study, to be familiar with the historical development of the Western United States. Therefore, in preparing this report, I have searched through many volumes and diaries, dealing with the accounts of the early trappers, explorers and pioneers.

Knowledge of the biota of North America has been accumulating in a rather definite manner since the last of the seventeenth century. Progress has been made during various well marked periods. I have divided my findings into two periods. The first one from 1800 to 1843 known as the fur trader period, and the second one, the Mormon Pioneer period from 1843 to 1855.

(1) Contribution No. 80.

It has been my aim to bring to busy zoologists, the little known and hidden information dealing with the natural history of the Great Basin during these periods. I have briefly summarized Fremont's, Stansbury's, and Remy & Brenchley's observations on the fauna and flora of the basin, placing emphasis on the buffalo in Utah, and the California Gull-Mormon Cricket episode.

DISCOVERY AND EXTENT OF THE GREAT BASIN

The following brief review of the discovery, extent, and character of the Great Basin is given in order that the reader may develop an appreciation of this great desert area.

The discovery of Great Salt Lake is an unsettled question. In the winter and spring of 1824-25 a party of General William H. Ashley's men visited the lake, embarked upon its waters in skin boats, and determined that it had no outlet (2). Other white men may have seen this body of water before Jim Bridger and his companions, but we have nothing authentic on the matter. The reports of the existence of a great lake by explorers and fur traders such as Baron Lahontan, 1689 (3) (4); Father Escalante 1776 (5); Mr. Lawrence 1790 (6); possibly the Spanish slave traders who went as far north as the Snake River by 1800 (7); Guthrie's map, 1811; and some members of parties going to Astoria in 1811-12, were in some instances, probably, based upon actual visitations to the lake rather than information from the Indians. Jim Bridger is, however, credited with the actual discovery of Great Salt Lake. Following the discovery of the Lake in 1824, it was visited by many trappers and explorers, a few being Peter Skeen Ogden in 1825; Etienne Provot, 1825 and William Ashley, 1826; J. R .Walker, 1833; and Captain J. C. Fremont in 1843. Fremont's party was the second to set sail upon the waters of Great Salt Lake. It is also to Fremont's (8) credit that the confines of the Great Basin were pointed out and the name "Great Basin" given to this desert area of the Western States. Since Fremont's observations were made about one hundred years ago and were so accurate, it seems desirable to include the following extract:

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(2) Chittenden. The American Fur Trader. Vol. II, p. 794.
(3) Stansbury. Expedition to the Great Salt Lake. pp. 151-54, map. 1852.
(4) Alter. Some useful early Utah Indian references. Utah History Quart. Vol. I, 1928, p. 26.
(5) Harris. The Catholic Church in Utah.
(6) Chittenden. Vol. II, p. 794.
(7) Hosmer. The Expedition of Lewis and Clark. Vol. I, Chapter 16.
(8) Fremont. Report of the Exploring Expedition to the Rocky Mountains in the year 1842 and to Oregon and North California in the years 1843-44. pp. 274-76.

"In arriving at the Utah Lake, we had completed an immense circuit of twelve degrees diameter north and south, and ten degrees east and west; and found ourselves in May, 1844, on the same sheet of water which we had left in September, 1843. The Utah is the southern limb of the Great Salt Lake; and thus we had seen that remarkable sheet of water both at its northern and southern extremity, and were able to fix its position at these two points. The circuit which we had made, and which had cost us eight months of time, and 3,500 miles of travelling, had given us a view of Oregon and of North California from the Rocky mountains to the Pacific ocean, and of the two principal streams which form bays or harbors on the coast of the sea. * * * * * *

"The structure of the country would require this formation of interior lakes; for the waters which would collect between the Rocky mountains and the Columbia or the Colorado, must naturally collect into reservoirs, each of which would have its little system of streams and rivers to supply it. This would be the natural effect; and what I saw went to confirm it. The Great Salt Lake is a formation of this kind, and quite a large one; and having many streams, and one considerable river, four or five hundred miles long, falling into it. This lake and river I saw and examined myself; and also saw the Wah-satch and Bear River mountains which enclose the waters of the lake on the east, and constitute, in that quarter, the rim of the Great Basin. Afterwards along the eastern base of the Sierra Nevada, where we travelled for forty-two days, I saw the line of lakes and rivers which lie at the foot of that Sierra; and which Sierra is the western rim of the Basin. In going down Lewis's fork and the main Columbia, I crossed only inferior streams coming in from the left, such as could draw their water from a short distance only; and I often saw the mountains at their heads, white with snow; which, all accounts said, divided the waters of the desert from those of the Columbia and which could be no other than the range of mountains which form the rim of the Basin on its northern side. And in returning from California along the Spanish trail, as far as the head of the Santa Clara fork of the Rio Virgen, I crossed only small streams making their way south to the Colorado, or lost in sand—as the Mo-ha-ve; while to the left, lofty mountains, their summits white with snow, were often visible, and which must have turned water to the north as well as to the south, and thus constituted, on this part, the southern rim of the Basin. At the head of the Santa Clara fork, and in the Vegas de Santa Clara, we crossed the ridge which parted the two systems of waters. We entered the Basin at that point, and have travelled in it ever since, having its southern rim (the Wah-satch mountain) on the right, and crossing the streams which flow down into it. The existence of the Basin is therefore an established fact in my mind; its extent and contents are yet to be better ascertained. It cannot be less than four or five hundred miles each way, and must lie principally in the Alta California; the demarcation latitude of 42° probably cutting a segment from the north part of the rim. Of its interior, but little is known. It is called a desert, and, from what I saw of it, sterility may be its prominent characteristic; but where there is so much water, there must be some oasis. The great river, and the great lake, reported may not be equal to the report; but where there is so much snow, there must be streams; and where there is no outlet, there must be lakes to hold the accumulated waters, or sands to swallow them up. In this eastern part of the Basin, containing Sevier, Utah, and the Great Salt lakes, and the rivers and creeks falling into them, we know there is good soil and good grass, adapted to civilized settlements. In the western part, on Salmon Trout rivers, and some other streams, the same remark may be made." (9)

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(9) Gilbert. Lake Bonneville. 1890. p. 5.

G. K. Gilbert, a distinguished American geologist, who made a careful study of Lake Bonneville, has the following to say of the Great Basin: "The maior part of the North American continent is drained by streams flowing to the ocean, but there are a few restricted areas having no outward drainage. The largest of these was called by Fremont, who first achieved an adequate conception of its character and extent, the "Great Basin," and is still universally known by that name. . . . . .

"The extreme length in a direction somewhat west of north and east of south is about 880 miles, the extreme breadth from east to west, in latitude 40° 30, is 572 miles, and the

The Mormon Pioneers entered Salt Lake Valley on July 24, 1847 and by the last of December of that year had explored some of the islands of Great Salt Lake and launched a boat upon Utah Lake, from which waters they obtained several species of fishes. In 1849-50 Captain Stansbury and his able assistant, Lieut. Gunnison explored the shore line of Salt Lake as well as all the islands.

THE FUR TRADER PERIOD

Prior to the Louisiana Purchase in 1803 and the Lewis and Clark Expedition up the Missouri, across the Rocky Mountains, and down the Columbia River to the Pacific Ocean in 1804-6, practically nothing was known about the natural history of the United States west of the Mississippi River (10). President Thomas Jefferson, a man with some training, as well as interest in the biological sciences, proposed in 1792 that a small party of trained men should be sent into the Louisiana Territory for the purpose of studying among other things the soil, plants, animals, and Indian tribes. Due to the activities of Lewis and Clark (11), one hundred fifty-five plant specimens, mostly collected on the return trip, were placed in the hands of the young English Botanist, Pursh. The majority of these plants proved to be new to science. Many of the bird and mammal species encountered on the trip were returned as skins and placed in Peale's Museum in Philadelphia. Alexander Wilson described some of the birds in his pioneer work on North American birds.

At about this same time Zebulon Montgomery Pike was making survey studies under the instruction of General Wilkinson. During the years 1805 and 1806 Pike (12) explored the source of the Mississippi; in 1806 and 1807 he conducted an expedition to the interior of the Louisiana Territory along the Arkansas and Red rivers to the Rocky Mountains; and finally in 1807 he made a tour through New Spain. Pike contributed very little, however, to the knowledge of the

total area is approximately 210,000 square miles. Of political divisions it includes nearly the whole of Nevada, the western half of Utah, a strip along the eastern border of California and a large area in the southern part of the State, another large area in southeastern Oregon, and smaller portions of southeastern Idaho and southwestern Wyoming. The southern apex extends into the territory of Mexico at the head of the peninsula of Lower California."

(10) Meisel, M. 1926. A Bibliography of American Natural History. Vol. II, p. 88.

(11) Meisel. Ibid. It is reported that in the Herbarium of the Academy of Natural Sciences of Philadelphia there are today "173 recognizable species mostly in fair condition; these include 55 of Pursh's types recognized as species at the present time, with 38 additional ones now for various reasons not considered tenable." The species were described by Pursh in 1814 in the first edition of "Florae Americae Septentrionalis" of two volumes, 725 pages and 24 plates.

All the zoological specimens, with the possible exception of a single specimen of Lewis's woodpecker, have been destroyed.

(12) Meisel. Ibid. P. 117.

fauna and flora of these regions. These expeditions did serve, however, to arouse an interest in the newly acquired territory, especially in the animal life from which great incomes for the furs and robes could be obtained. This period between 1804 and 1843 was a thrilling one for the fur trader and explorer, and one we know but little about. Chittenden (13) has pointed out that these men were the "Pathfinders of the west and not those later official explorers whom posterity so recognizes. No features of western geography were ever discovered by government explorers after 1840. Everything was already known, and had been for fully a decade." Washington Irving (14) concurs in this point of view saying:

"The consequence is that the Rocky Mountains and the interior regions from the Russian possessions in the north, down to the Spanish settlements of California, have been transversed and ransacked in every direction by bands of hunters and Indian tribes; so that there is scarcely a mountain pass, or defile, that is not known and treaded in their restless migration, nor a nameless stream that is not hunted by the lonely trapper."

During this period there were adventurous souls, other than the trappers, who traversed the mountain states. The English naturalist, John Bradbury, 1809-11, studied the plants and animals of the Mississippi and Missouri River valleys. In his *Travels in North America* are to be found many interesting observations. Likewise Thomas Nuttall and J. K. Townsend contributed to our knowledge of the fauna and flora of the Missouri, as well as the Snake and Columbia River valleys. In 1834 these two gentlemen observed and explored much of this territory with the companies of N. J. Wyeth and Jason and Lee. Many of the Nuttall and Townsend specimens of plants and animals from the west were described during the late forties and fifties by workers at the Academy of Natural Sciences in Philadelphia, which has been since its founding in 1812, one of the most noted institutions of this country. In the publications of this institution may be found contributions by such workers as John Bachman, J. J. Audubon, George Ord, Thomas Say, John L. LeConte, S. W. Woodhouse, Thomas Nuttall, William Gambel, J. K. Townsend, John Cassin, Joseph Leidy, and others, which appeared before 1850 and which deal with the biota of the western states.

One of the earliest and most skillfully manned and equipped expeditions, for the study of the territory between the Mississippi River and the Rocky Mountains, was sent out by the Secretary of War, J. C.

(13) Chittenden. Op. Cit. Vol. I, Author's preface. p. x.
(14) Irving, W. 1843. The Adventures of Captain Bonneville. p. 36.

Calhoun, under the direction of Major Stephen H. Long (15), on May 5, 1819. The party left Pittsburgh going down the Ohio River in a steamer, in which they reached St. Louis on June 9. From here they traveled up the Missouri. The party consisted of Dr. William Baldwin, botanist, physician and surgeon; Major John Biddle; August E. Jessup, geologist; Mr. Thomas Say, zoologist; Mr. T. R. Peale, assistant naturalist; Mr. Samuel Seymour, artist; Lieutenant James D. Graham and Cadet William H. Swift, assistant topographers and drillers; and Major Stephen H. Long, a topographical engineer and chief of the party.

After considerable disappointment and change in the personnel of the party it returned in October 1820, after visiting much of the territory along the Missouri and Arkansas rivers, the area around where Denver is now located, Pikes Peak, and southward towards the Red River. In spite of Say's losing his journals he made many contributions to our knowledge of the animals of this new territory (16).

Other parties, mainly under the direction of naturalists, studied this region during the period 1804 to 1843. In 1785 Andre Michaux came to North America and for several years collected and studied the flora of the Louisiana Territory. He wrote a number of volumes which have been used by explorers and students (17). Prince Paul of Wurtemburg in 1823, as well as years later, collected along the Missouri. In 1833 Maximilian, Prince of Wied, traversed the Missouri River almost to its source. His observations are recorded in (18) a volume which is rarely seen by zoologists of the intermountain states. J. N. Nicollet during the years 1836-40 explored much of the Mississippi and Missouri River Valleys. Dr. John Richardson and William Swanson as early as 1829 contributed considerable to our knowledge of the zoology of the northern parts of British America.(19)

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(15) Meisel. Vol. II, p. 394.

(16) From Weiss and Ziegler's, Thomas Say, 1931, we learn that "In addition to what has been noted, Say described fossil shells, birds, snakes, shrews, squirrels, a deer, a lizard, newt, a sand rat, and drew up descriptions of previously described animals such as wolves, serpents, birds, toads, rats, the prairie dog, etc., all of which are recorded in footnotes in the Long report. Insects are not described in this report and little notice is made of them. They were collected, however, and mention is made of an Otto warrior, "Little black bear," who examined the expedition's collection at Engineer Cantonment and recognized a considerable number, telling which inhabited the water and which the land and detailing with much accuracy the habits of some species, but along with it also repeating some accounts which were absurd. Altogether several thousand insects were collected, of which hundreds were new to science."

(17) Michaux wrote the Flora Boreali-Americana (2 Vols.) in 1803. Fremont, on page 270, comments on the cottonwood along the Santa Clara Creek, which were then in fruit, being different from species found in Michaux's Sylva.

(18) Travels in the Interior of North America by Maximilian, Prince of Wied, with numerous engravings on wood and a large map translated from the German by H. Evans Lloyd. To accompany the original series of eighty-one elaborately colored plates, size, Imperial Folio. London Ackermman & Co., 96 Strand, MDCCCXLIII.

(19) Fauna Boreali-Americana. London, John Murray, 1829.

Many of the insects known to occur in the Great Basin were described in 1829 by Eschscholtz in his Zoological Atlas. These were collected in Russian America and California by staff members of the Imperial Russian Navy Expedition during the years 1823-26. In 1843 Mannerheim published a Coleopterous fauna of California and Russian America which contained descriptions of 300 species. Later papers by Motschulsky and Mannerhein increased the species of Coleoptera known from Pacific North America to more than 600 species. Dr. J. K. Townsend made a collection of insects which was taken back to Philadelphia and reported upon by Harris, Garmar, Erickson, and Reiche (20).

Dr. F. A. Wislizenus of St. Louis published a small volume in German in which he reported on his observations made in 1839 while exploring in the Rocky mountains.

While none of these early explorers entered the Great Basin, they were collecting the common plant and animal species of the western territory and taking them to centers of biological activity on the Atlantic sea-board, as well as the museums of Europe. Thus by the close of this period I have been able to list 60 species of mammals, 101 birds, 2 reptiles, 3 fish, 600 insects, and many plants that had been described and are now found within the Great Basin.

During this fur trader period considerable ecological change was taking place. The balance of nature was being upset by the white man which resulted in a great reduction in numbers, as well as a change in distribution of many of the fur bearers. The beaver, mink, otter, foxes, buffalo, elk, moose, and mountain sheep are some of the species which were most noticeably affected.

THE BUFFALO IN UTAH

Of all the species encountered by the trappers, the buffalo, *Bison bison bison* (L.) was most sorely dealt with. It was the general utility animal of the plains, serving the Indians and trappers alike with food, clothing, and shelter. During the colonial days this species ranged from the Rocky Mountains in the west, Canada on the north, the Gulf region on the south, to the Alleghenys on the east. Its numbers ran into the millions, yet by 1800 it was not to be found east of the Mississippi, and by 1900 it was practically exterminated, save for a few herds found in protected areas.

(20) LeConte. Report upon Insects Collected on the Survey. Vol. XII, Book II, Railroad survey reports, 1860.

We have very little definite information on the early distribution of the buffalo west of the Rocky Mountains in the Great Basin. Dr. J. A. Allen (21) believed that there was "abundant proof of its former existence over a vast area west of this supposed boundary including a large part of the so-called Great Basin of Utah, the Green River Plateau, and the plains of the Columbia. It is probably not half a century since it ranged westward to the Blue Mountains of Oregon and the Sierra Nevada Mountains of California."

Escalante (22), 1776, reports killing several buffaloes in Colorado, before crossing the Green River (San Buenaventura) into Utah, but he fails to mention seeing or tracking the buffalo in Utah. Lewis and Clark (23) found the buffalo along the Missouri River until they entered the mountains in Montana, from which point on to the Columbia River and return they were without buffalo meat. In 1825 General Ashley (24) mentions the buffalo as being fairly common in Echo Park at the confluence of the Yampa and Green Rivers. During the winter of 1824-25 when Jedediah Smith made a trip down the Bear River into Salt Lake Valley he reports that buffalo were plentiful all along the way (25). Smith also found buffalo in Utah Valley in July, 1826, when he made his trip from Salt Lake Valley to Southern California (26). Mr. J. R. Walker, a leader of one of Bonneville's parties, reports that they killed buffalo in Great Salt Lake Valley in August, 1833 (27).

Captain Fremont (28) in August, 1843, while descending the Bear River found the Indians poor and with little food, except some roots. They complained because of the disappearance of the game, especially the buffalo. At this date the buffalo had disappeared from Utah and the Snake River valleys. The following extract from Fremont's jour-

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(21) J. A. Allen. History of The American Bison. Ninth annual report U. S. Geological and Geographical Survey of the Territories by F. V. Hayden, 1877.

(22) Harris, Dean. The Catholic Church in Utah, 1776-1909, p. 166.

(23) Hosmer. Ibid. Vol. I, Chapter XII.

(24) Dale. The Ashley-Smith explorations, 1822-29, p. 146, reports, "Here we found a luxurious growth of sweet-bark on round-leaf Cottonwood and a number of buffalo.

(25) Ibid. Page 159.

(26) Ibid. Page 187. "My general course on leaping the Salt Lake was S. W. and W. passing the little Uta Lake and ascending Ashley's river which empties into the little Uta Lake. From this lake I found no more signs of buffalo. There are a few antelope and mountain sheep and an abundance of black-tailed hares." (No doubt the Uta Lake refers to Utah Lake and Ashley river to the Sevier River.)

(27) Chittenden. Vol. I, p. 407. "Walker's (a) party consisting of forty men left Green River July 24, 1833. They went directly to the valley of Great Salt Lake where they started to lay in their final supply of buffalo meat. The last buffalo was killed August 4th and three days later the party bade farewell to the lake at its western extremity and took a westerly course into the most extrusive and barren plains I have ever seen."

(a) This is reported by Mr. Zenas Leonard who was a clerk for Mr. Walker during the 1833 California expedition. Leonard was a native of Pennsylvania and had spent two years in the west engaged in hunting and trapping. He met Walker at the Green River rendezvous and was engaged to assist in the westward trips.

(28) Fremont. Ibid. Pages 143-44.

nal is of value as it gives the general consensus of opinion as to the movements and distribution of the buffalo in 1843:

"A great portion of the region inhabitated by this nation formerly abounded in game; the buffalo ranging about in herds, as we had found them on the eastern waters, and the plains dotted with scattered bands of antelope; but so rapidly have they disappeared within a few years, that now as we journeyed along, an occasional buffalo skull and a few wild antelope were all that remained of the abundance which had covered the country with animal life.

"The extraordinary rapidity with which the buffalo is disappearing from our territories will not appear surprising when we remember the great scale on which their destruction is yearly carried on. With inconsiderable exceptions, the business of the American trading posts is carried on in their skins; every year the Indian villages make new lodges, for which the skin of the buffalo furnishes the material; and in that portion of the country where they are still found, the Indians derive their entire support from them, and slaughter them with a thoughtless and abominable extravagance. Like the Indians themselves, they have been a characteristic of the Great West; and as, like them, they are visibly diminishing, it will be interesting to throw a glance backward through the last twenty years, and give some account of their former distribution through the country, and the limit of their western range.

"The information is derived principally from Mr. Fitzpatrick, supported by my own personal knowledge and acquaintance with the country. Our knowledge does not go farther back than the spring of 1824, at which time the buffalo were spread in immense numbers over the Green River and Bear River valleys, and through all the country lying between the Colorado, or Green River of the Gulf of California, and Lewis's fork of the Columbia River; the meridian of Fort Hall then forming the western limit of their range. The buffalo then remained for many years in that country, and frequently moved down the valley of the Columbia, on both sides of the river as far as the *Fishing falls*. Below this point they never descended in any numbers. About the year 1834 or 1835 they began to diminish very rapidly, and continued to decrease until 1838 or 1840, when, with the country we have just described, they entirely abandoned all the waters of the Pacific north of Lewis's fork of the Columbia. At that time, the Flathead Indians were in the habit of finding their buffalo on the heads of the Salmon River, and other streams of the Columbia; but now they never meet with them farther west than the three forks of the Missouri or the plains of the Yellowstone River.

"In the course of our journey it will be remarked that the buffalo have not so entirely abandoned the waters of the Pacific, in the Rocky mountain region south of the Sweet Water, as in the country north of the Great Pass. This partial distribution can only be accounted for in the great pastoral beauty of that country, which bears marks of having long been one of their favorite haunts, and by the fact that the white hunters have more frequented the northern than the southern region—it being north of the South Pass that the hunters, trappers, and traders, have had their rendezvous for many years past; and from that section also the greater portion of the beaver and rich furs were taken, although always the most dangerous as well as the most profitable hunting ground.

"In that region lying between the Green or Colorado river and the head waters of the Rio del Norte, over the Yampah, Kooya, White, and Grand rivers—all of which are the waters of the Colorado—the buffalo never extended so far to the westward as they did on the waters of the Columbia; and only in one or two instances have they been known to descend as far west as the mouth of White river. In travelling through the country west of the Rocky mountains, observation readily led me to the impression that the buffalo had, for the first time, crossed that range to the waters of the Pacific only a few years prior to the period we are considering; and in this opinion I am sustained by Mr. Fitzpatrick, and the older trappers in that country. In the region west of the Rocky mountains, we never meet with any of the ancient vestiges which, throughout all

the country lying upon their eastern waters, are found in the great highways, continuous for hundreds of miles, always several inches and sometimes several feet in depth, which the buffalo have made in crossing from one river to another, or in traversing the mountain ranges. The Snake Indians, more particularly those low down upon Lewis's fork, have always been very grateful to the American trappers, for the great kindness (as they frequently expressed it) which they did to them, in driving the buffalo so low down the Columbia river.

"The extraordinary abundance of the buffalo on the east side of the Rocky mountains, and their extraordinary diminution, will be made clearly evident from the following statement: At any time between the years 1824 and 1836, a traveller might start from any given point south or north in the Rocky Mountain Range, journeying by the most direct route to the Missouri River; and during the whole distance, his road would be always among large bands of buffalo, which would never be out of his view until he arrived almost within sight of the abodes of civilization.

"At this time, the buffalo occupy but a very limited space, principally along the eastern base of the Rocky Mountains, sometimes extending at their southern extremity to a considerable distance into the plains between the Platte and Arkansas Rivers, and along the eastern frontier of New Mexico as far south as Texas."

Captain Fremont and General Chittenden both report that the various fur companies, from about 1830 to 1840, annually took from the west about 100,000 buffalo robes.

When the pioneers of 1847 entered the Salt Lake Valley they found only the wasteing bones of the once abundant mammal of the American Plains. Mr. Robert S. Bliss (29), a Mormon Battalion member, after being discharged, returned from San Diego by way of Sutter's Fort, Donner Pass, across Nevada to Fort Hall, then south to Salt Lake City, made the following entry in his journal on October 20, 1847: "Continued down Sick Creek twenty miles and encamped; saw many buffalo bones since we left the Fort." (Fort Hall on the Snake River.)

Dr. J. A. Allen reports that "Mr. Henry Gannet, astronomer of Dr. Hayden's Survey, informs me that the Mormon Danite, 'Bill' Hickman, claims to have killed the last buffaloes in Salt Lake Valley about 1838." This seems to be an error, in the first place, as to the date, since this is nine years before the Mormons reached the Salt Lake Valley. In the second place, if it did refer to 1848, we have no evidence from pioneer diaries, journals, or government reports, that buffaloes were seen or heard of in Utah in 1847 or 1848.

Mr. Washburn Chipman, a pioneer of 1847 and one of the founders of American Fork City, had Jim Bridger stay over night with him in 1849, while he was living in Big Cottonwood. Bridger reported that, about 1829 to 1834, the buffalo were common in Salt Lake and

(29) Bliss, Robert S. Journal. The Utah Historical Quarterly. Vol. 4, No. 4, 1931.

Utah Valleys, but that due to a heavy snow storm all of them were killed (30).

Mr. M. S. Garretson's (31) interesting book gives a vivid picture of the destruction of the buffalo. Thousands upon thousands were killed to supply meat for the men of the railroad camp or solely for their robes. During the years between 1868 and 1878 more than a million robes were sold in St. Louis and Ft. Worth, Texas. The shame of slaughter was not confined to men of our country alone, since sportsmen of wealth came from Russia, England, Germany, and other parts of Europe to have a hand in the extermination.

In summarizing the findings on the buffalo in Utah and the Great Basin, it appears that for hundreds of years it had been widely scattered throughout the northwestern portion of the Basin, from the Sierra Nevada Mountains to eastern Oregon, then along the Snake River Valley into northern Utah. The evidence supporting this wide distribution is based in the main upon semi-fossil and surface remains found by fur trappers and explorers. On the other hand, there is much evidence for the belief that the large herds of buffalo found along the headwaters of the Bear, Snake, and Columbia Rivers between the years 1817 and 1840 had been driven into the mountains by the western movement of civilization. It also appears that they were driven back or exterminated by the trappers, Indians, and perchance a few hard winters. In any event when Captain Fremont came to Utah in 1843 he found that the buffalo had disappeared from the Great Basin.

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(30) I am indebted to Dr. William J. Snow, Prof. of Western History at Brigham Young University, for the following extract from a paper written by Mr. L. B. Adamson on "The Early History of American Fork." Brother Chipman relates that he remembers seeing the remains of a buffalo carcass near the Niels Nelson Spring southwest of town, and in the spring of 1849 while in Big Cottonwood, he had stay with him over night, a frontiersman named Jim Bridger. This man was sandy complexioned and was clad in the skins of animals. He related that fifteen or twenty years before, the country contained many buffalo. An immense snow storm came on which piled the snow eighteen feet deep in the valleys and completely covered the buffalo. The frontiersman claimed that he did not see the sun for thirty-four days. He said in Salt Lake Valley while going over the deep snow on snow shoes, that he came across breathing holes in the snow, below which was a buffalo. The buffalo all perished.

From J. C. Alter's James Bridger, 1925, page 386, we quote: "Colonel Inman declared that Bridger told him, and also many others, at various times, that in the winter of 1830 it began to snow in the valley of the Great Salt Lake, and continued for seventy days without cessation. The whole country was covered to a depth of seventy feet, and all the vast herds of buffalo were caught in the storm and died, but their carcasses were perfectly preserved."

"When spring came, all I had to do," declared he, "was to tumble 'em into Salt Lake an' I had pickled buffalo enough for myself and the whole Ute nation for years!" He said that on account of that terrible storm which annihilated them there have been no buffalo in that region since.

This sounds like one of Bridger's "tall" stories for which he was justly famous. It will be recalled that Walker's party killed buffalo in Salt Lake Valley in the Autumn of 1833. I believe the slaughter of the buffalo for its robe was the prime cause for its disappearance from the Rocky Mountains and Utah.

(31) Garretson. The American Bison. 1938.

MORMON PIONEER PERIOD (1843-1855)

Captain John C. Fremont, the Georgian mathematician, explorer and politician, made the first noteworthy contribution to the natural history of the Great Basin. Under the orders of Col. J. J. Abert (32), Chief of the Topographical Bureau, Fremont was instructed to conduct a survey of the Great West for the purpose of completing a reconnaissance of the interior territory of our country between the Rocky Mountains and the Pacific Ocean.

Fremont's party consisted of 39 men, among whom were Mr. Thomas Fitzpatrick and Mr. Charles Preuss. Captain Fremont acted as topographer, naturalist and journalist of the party. His comments upon the plants and animals found along the course of the entire trip marks him as a keen student of natural history. Through his efforts many plants collected within the Great Basin were jointly described with Dr. Torrey.

The following is a summary of the observations made upon the flora and fauna by Fremont after he reached the Bear and Roseaux or Reed Rivers in northern Utah, on September 1, 1843. He remained here until September 15, when he went on north to the Snake River, and then to Vancouver on the Pacific Coast. In presenting the species mentioned, I have recorded the observations as they occur in Fremont's report as follows:

September 1, 1843. PLANTS:—"On this upper plain the grass was everywhere dead; and among the shrubs with which it was almost exclusively occupied, (arte-misia being the most abundant), frequently occurred handsome clusters of several species of *dicteria* in bloom. *Purshia tridentata* was among the frequent shrubs. Descending to the bottoms of Bear river, we found good grass for animals, and encamped about 300 yards above the mouth of Roseaux, which here makes its junction, without communicating any of its salty taste to the main stream, of which the water remains perfectly pure. On the river are only willow thickets, *(salix longifolia)*, and in the bottoms the abundant plants are canes, solidago, and helianthi, and along the banks of Roseaux are fields of *malva rotundifolia*. (Fremont was traveling southward between the Roseaux and Bear Rivers.)

September 2. BIRDS:—"As we were stealing quietly down the stream, trying in vain to get a shot at a strange large bird that was numerous among the willows, but very shy, we came unexpectedly upon several families of *Root Diggers*, who were encamped among the rushes on the shore, and appeared very busy about several weirs or nets which had been rudely made of canes and rushes for the purpose of catching fish."

MOLLUSKA:—"Immediately where we landed, the high arable plain on low flats, very generally occupied by salt marshes, or beds of shallow lakes, whence the water had in most places evaporated, leaving their hard surface encrusted with a shining white residuum, and absolutely covered with very small *univalve* shells."

September 3. BIRDS:—"The water fowl made this morning a noise like

(32) Fremont. Ibid.

thunder. A pelican, *(pelecanus onocrotalus)*, was killed as he passed by, and many geese and ducks flew over the camp."

"Several of the people waded out into the marshes, and we had to-night a delicious supper of ducks, geese, and plover."

PLANTS:—"On the dry salt marsh here, is scarce any other plant than *salicornia herbacea*." (These observations were made on the Bear River Marsh area.)

September 5. PLANTS:—"Here we halted for a few minutes at noon, on a beautiful little stream of pure and remarkably clear water, with a bed of rock in *situ*, on which was an abundant water plant with a white blossom. There was good grass in the bottoms; and, amidst a rather luxuriant growth, its banks were bordered with a large showy plant, *(eupatorium purpureum)*, which I here saw for the first time. We named the stream Clear creek.

We continued our way along the mountain, having found here a broad, plainly beaten trail, over what was apparently the shore of the lake in the spring; the ground being high and firm, the soil excellent and covered with vegetation, among which a leguminous plant, *(glycyrrhiza lepidota)*, was a characteristic plant."

"Near a remarkable rocky point of the mountain, at a large spring of pure water, were several hackberry trees, *(celtis)*, probably a new species, the berries still green; and a short distance farther, thickets of sumach *(rhus)*."

BIRDS:—"On the plain here I noticed blackbirds and grouse." (Today the party was moving southward along the base of the Wasatch Mountains from about where Brigham City is located.)

September 6. PLANTS:—"Leaving the encampment early, we again directed our course for the peninsular *butte* across a low shrubby plain, crossing in the way a slough-like creek with miry banks, and wooded with thickets of thorn, *(cratacgus)*, which were loaded with berries."

"So far as we could see, along the shores there was not a solitary tree, and but little appearance of grass; and on Weber's fork, a few miles below our last encampment, the timber was gathered into groves, and then disappeared entirely. As this appeared to be the nearest point to the lake where a suitable camp could be found, we directed our course to one of the groves, where we found a handsome encampment, with good grass and an abundance of rushes, *(equisetum hyemale)*."

September 7. PLANTS:—"The bottoms along the river were timbered with several kinds of willow, hawthorn, and fine cottonwood trees, *(populus canadensis)*, with remarkably large leaves, and sixty feet in height by measurement."

AMPHIBIA:—"The summer frogs were singing around us, and the evening was very pleasant, with a temperature of 60°—a night of a more southern autumn. For our supper we had *yampah*, the most agreeably flavored of the roots, seasoned by a small fat duck, which had come in the way of Jacob's rifle."

September 8. BIRDS:—"The evening was mild and clear; we made a pleasant bed of the young willows; and geese and ducks enough had been killed for an abundant supper at night, and for breakfast the next morning. The stillness of the night was enlivened by millions of water fowl." (On Weber R. delta.)

September 9. BIRDS:—"All this place was absolutely covered with flocks of screaming plover."

INSECTS:—"Among the successive banks of the beach, formed by the action of the waves, our attention, as we approached the island, had been attracted by one ten to 20 feet in breadth, of a dark-brown color. Being more closely examined, this was found to be composed, to the depth of seven or eight and twelve inches, entirely of the larvae of insects, or, in common language, of the skins of worms, about the size of a grain of oats, which had been washed up by the waters of the lake."

PLANTS:—"From the point where we were standing, the ground fell off on every side to the water, giving us a perfect view of the island, which is twelve or thirteen miles in circumference, being simply a rocky hill, on which there is neither water nor trees of any kind; although the *Fremontia vermicularis*, which was in great abundance, might easily be mistaken for timber at a distance. The

plant seemed here to delight in a congenial air, growing in extraordinary luxuriance seven to eight feet high, and was very abundant on the upper parts of the island, where it was almost the only plant. This is eminently a saline shrub; its leaves have a very salt taste; and it luxuriates in saline soils, where it is usually a characteristic. It is widely diffused over all this country. A chenopodiaceous shrub, which is a new species of obione, was equally characteristic of the lower parts of the island. These two are the striking plants on the island, and belong to a class of plants which form a prominent feature in the vegetation of this country. On the lower parts of the island, also, a prickly pear of very large size was frequent. On the shore, near the water, was a woolly species of *phaca;* and a new species of umbelliferous plant, *(leptotaenia),* was scattered about in very considerable abundance. These constituted all the vegetation that now appeared upon the island."

Birds:—"In our excursions about the island, we did not meet with any kind of animal; a magpie, and another larger bird, probably attracted by the smoke of our fire, paid us a visit from the shore, and were the only living things seen during our stay. (This island is now known as Fremont Island.)

September 10. Plants:—"*Lynosiris grayeotens,* and another new species of Obione, (O. contertifolia—*Torr. & Frem.*), were growing on the low grounds, with interspersed spots of an unwholesome salt grass, on a saline clay soil with a few other plants."

"*Artemisia tridentata* was very abundant, but the plants were principally saline; a large and vigorous chenopodiaceous shrub, five to eight feet high, being characteristic, with *Fremontia vermicularis,* and a shrubby plant which seems to be a new *Salicornia.*" (On this date Fremont was back on the Weber River delta.)

September 12. Plants:—"This creek is here unusually well timbered with a variety of trees. Among them were birch *(betula),* the narrow-leaved poplar *(populus angustifolia),* several kinds of willow *(salix),* hawthorn *(crataegus),* alder *(alnus viridis),* and *cerasus,* with an oak allied to *quercus alba,* but very distinct from that or any other species in the United States."

Birds:—"We had to-night a supper of sea gulls, which Carson killed near the lake."

Insects:—"Although cool, the thermometer standing at 47°, musquitoes were sufficiently numerous to be troublesome this evening." (Near Brigham City.)

September 13. Plants:—"One of these streams, which forms a smaller lake near the river, was broken up into several channels; and the irrigated bottom of fertile soil was covered with innumerable flowers, among which were purple fields of *eupatorium purpureum,* with helianthi, a handsome solidago *(S. canadensis),* and a variety of other plants in bloom."

September 14. Plants:—"We found on the way two families of Snake Indians, from whom we purchased a small quantity of *kooyah.* They had piles of seeds, of three different kinds, spread out upon pieces of buffalo robe; and the squaws had just gathered about a bushel of the roots of thistle *(circium Virginianum).* They were about the ordinary size of carrots and, as I have previously mentioned, are sweet and well flavored, requiring only a long preparation."

September 15. Plants:—"By the gift of a knife, I prevailed upon a little boy to show me the *kooyah* plant, which proved to be *valveriana edulis.* The root, which constitutes the *kooyah,* is large, of a very bright yellow color, with the characteristic odor, but not so fully developed as in the prepared substance. It loves the rich moist soil of river bottoms, which was the locality in which I always afterwards found it. It was now entirely out of bloom; according to my observation, flowering in the months of May and June. In the afternoon we entered a long ravine leading to a pass in the dividing ridge between the waters of Bear river and the Snake river, or Lewis's fork of the Columbia; our way being very impeded, and almost entirely blocked up, by compact fields of luxuriant artemisia. Taking leave at this point of the waters of Bear river, and of the geographical basin which encloses the system of rivers and creeks which belong

to the Great Salt Lake, and which so richly deserves a future detailed and ample exploration, I can say of it, in general terms, that the bottoms of this river, (Bear), and of some of the creeks which I saw, form a natural resting and recruiting station for travelers, now, and in all times to come. The bottoms are extensive; water excellent; timber sufficient; the soil good, and well adapted to the grains and grasses suited to such an elevated region. A military post, and a civilized settlement, would be of great value here; and cattle and horses would do well where grass and salt so much abound. The lake will furnish exhaustless supplies of salt. All the mountain sides here are covered with a valuable nutritious grass, called bunch grass, from the form in which it grows, which has a second growth in the fall. The beasts of the Indians were fat upon it; our own found it a good subsistence; and its quantity will sustain any amount of cattle, and make this truly a bucolic region."

Captain Fremont left Fort Vancouver on his return trip, November 10th, going by way of "Tlamath" lake in a southwesterly direction. He again entered the Great Basin traversing the desert just east of the Sierra Nevada, here he saw Pyramid Lake and the streams of the region. *Ephedra occidentalis* was fairly common and is frequently mentioned as occurring in other parts of the basin. Nuts from a pine tree, common in the Great Basin, were given to the party by the Indians. Fremont reports this incident as follows:

"A man was discovered running towards the camp as we were about to start this morning, who proved to be an Indian of rather advanced age—a sort of forlorn hope, who seemed to have been worked up into the resolution of visiting the strangers who were passing through the country. He seized the hand of the first man he met as he came up, out of breath, and held on, as if to assure himself of protection. He brought with him in a little skin bag a few pounds of the seeds of a pine tree, which today we saw for the first time, and which Dr. Torrey has described as a new species, under the name of *pinus monophyllus;* in popular language, it might be called the nut pine. We purchased them all from him. The nut is oily, of very agreeable flavor, and must be very nutritious, as it contains the principal subsistence of the tribes among which we were now travelling."

It was now mid-winter but Fremont was determined to cross the Sierra Nevada Mountains and get new supplies at Sutter's Fort on the Sacramento River. From January 30, to February 25, 1844, they struggled through the cold and snow of the mountains. The party reached Fort Sutter on March 6th, and left on the 22nd, on their homeward march. They traveled up the San Joaquin Valley, going south about 500 miles before they could get through the Sierra Nevada Mountains by way of the pass discovered by Joseph Walker. From here the march was across the Great Basin desert to Las Vegas, Nevada; then north to the Santa Clara Creek in southwestern Utah, and on to Utah Lake about 85 miles south of Weber River and Great Salt Lake where Fremont spent several days in September, 1843.

Very little is said about the flora and fauna of southwestern Utah

and the following is about the only observation made on the Utah Lake life:

"Here the principal plants in bloom were two, which were remarkable as affording to the Snake Indians—the one an abundant supply of food, and the other the most useful among the applications which they use for wounds. These were the kooyah plant, growing in fields of extraordinary luxuriance, and *convollaria stellat*, which, from the experience of Mr. Walker, is the best remedial plant known among those Indians. A few miles below us was another village of Indians, from which we obtained some fish—among them a few salmon trout, which were very much inferior in size to those along the California mountains. The season for taking them had not yet arrived; but the Indians were daily expecting them to come up out of the lake."

On the 27th of May, Fremont led his party up Spanish Fork Canyon then east along the south base of the Uintah Mountains, across the Green River, or the Seeds-kee-dee, or prairie hen river, into Colorado by way of Yampa Valley. As a result of this expedition and the publication of the findings in 1845, there was available for the many western bound caravans, a guide and source of information on the great western interior territory. For the first time it was pointed out that the Great Basin, in the main, was a desert waste.

The Mormon pioneers entered the Great Basin and commenced the establishment of a great inland empire on July 24, 1847. Much to our regret, very little is found in the early diaries, journals and publications, concerning the plants and animals found in the Utah territory. Very few, if any of the pioneers, had any schooling or interest in zoology or botany, which no doubt accounts for the paucity of recorded observations on the fauna and flora of this region. The following reports help to give a picture of the plant cover in the valleys and along the foothills of the Wasatch Mountains.

Fremont reports that bunch grass was common along the Roseaux and Bear Rivers, also in the Malade and Cache Valleys. From Mr. John R. Young, a pioneer of 1847, we learn that Salt Lake Valley was covered with scattered bunch grass and prickley pear (33). Mr. Washburn Chipman reported that in 1850 bunch grass and sage-brush

(33) Young, John R. Reminiscenes of John R. Young. The Utah Historical Quarterly, Vol. 3, No. 3, p. 63. "From our cabin in the mouth of City Creek Canyon in 1847, one could see a lone cedar tree on the plain southeast of us, and on the south fork of the creek, about where Main and Third South Streets intersect, stood seven wind swept, scraggy cottonwood trees. On the north side of City Creek stood a large oak tree. No other trees were visible in the valley.

"The plain was covered with scattering bunch grass eight or ten inches high and occasional patches of low flat prickly pears. We barefooted lads had to be careful where we stepped. Along the banks of the creek were thin strips of willows, rose briars, and squash bush. In the swamps were patches of coarse wire grass, bull rushes, and cat tails. If ever Lawyer Baskin wet his moccasins while riding through the valley on horseback it would be because he rode across the sloughs. For several years, in the early days of Salt Lake, people went to Toocle, American Fork, or Ogden to get hay."

covered much of the land around American Fork north and east of Utah Lake. J. W. Gunnison in 1852, says the hill-sides furnish bunch grass only during the warm months of the year (34).

Escalante and Fremont both mentioned the abundant grass for pasturage in Utah Valley.

The grass and brush covered valleys and bench lands were soon plowed and made to produce food, by means of irrigation. By August 26, eighty-four acres had been plowed and planted to corn, potatoes and grain. By September 19th, 1847 the population of 147 was increased to 1700 persons, which made it necessary to ration the food supplies. Before the winter was over many of the inhabitants of the valley resorted to the use of plant roots, such as the thistle, for food. Game animals were fairly common, but in spite of this the pioneers were many times during the first few years forced to live upon roots, like the native "Digger" Indians (35). In the spring of 1848, 5000 acres were plowed and planted to grain. The climate was favorable and indications were that a good crop would be produced. Then occurred a biological episode in which two species, the California Gull, *Larus californicus* Lawrence, and the Mormon Cricket, *Anabrus simplex* Hald., played the major roles.

THE GULLS AND CRICKETS

That the crickets were abundant in Salt Lake Valley when the pioneers came is evident from the following diary entry made by William Clayton, who was a member of an advanced group which entered the valley through Emigration Canyon:

"The ground seemed literally alive with the very large black crickets crawling around on grass and bushes. They look loathsome but are said to be excellent for fattening hogs."

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(34) Gunnison. History of the Mormons. 1852. "Artemisias and Salicornias contend for a miserable existence on portions of the plains; and bunch grass furnishes grazing on the hill-sides for antelope and deer. P. 15.

The valleys afford perennial pasturage, but the hill-sides furnish the bunch grass only during the warm months of the year. It seeds in summer, and is germinated by the autumnal rains, and grows under the snow covering of winter. P. 17.

(35) Gunnison. Op. cit., p. 20. "Wild game abounds for the table, in the antelope, deer, tribes and feathered tribes—the bear, panther, and smaller animals of prey, for the adventurous sportsman, range through hill, valley, and desert; and the angler can choose his fish, either in the swift torrents of the kanyons, where the trout delights to live, or in the calmer currents on the plains, where he will find abundance of the pike, the perch, the bass, and the chub. Along the brackish streams, from the saline springs, grows a thick tangled grass, and the marshy flats are covered with fine reeds or dense festucas. In early summer the shepherd lads fill their baskets with the eggs deposited in that cover by the goose, the duck, the curlew, and plover; or, taking a skiff,they can row to the Salt Lake islands, and freight to the water's edge with those layed for successive broods by the gull, the pelican, the blue heron, the crane, and the brandt."

From Orson Pratt's journal under the date of July 22, 1847 (36), we find the following:

"We found the drier places swarming with very large crickets about the size of a man's thumb."

George A. Smith in a letter to Henry W. Bigler, a member of the Mormon battalion, dated July 29th, five days after entering the valley, says "the whole face of the country was covered with large black crickets." (37) Finally John Steele on August 29, 1847 reports that he was "planting buckwheat, irrigating crops, killing crickets, etc." (38)

Because the crickets have gone through cycles of abundance since the episode under discussion, I am inclined to believe that they were in 1847-48 at the peak of one of these cycles. In any event the thousands of acres of grain in 1848 proved to be a choice new area for the moving hordes of crickets.

From Eliza R. Snow's journal, we find that by May 28, 1848, the crickets had begun to damage the crops. The winter was a mild one, and the early spring made the hatching and development of the crickets earlier than usual. Mrs. Snow reported in her journal, "This morning's frost in unison with the ravages of the crickets for a few days past produces many sighs, and occasionally some long faces with those that for the moment forget that they are Saints." By June 4th, Isaac C. Haight (39) reports considerable damage to the grain from crickets. From letters written on June 9 and 21 (40), to President Brigham Young, then in Missouri helping other Saints to reach the Salt Lake Valley, we learn that the sea gulls had come to the aid of the desperate saints. The following extracts from these letters throw some light on the feelings of the people and their interpretation of the episode.

June 9, 1848. ".... As to our crops, there has been a large amount of spring crops put in, and they were doing well till within a few days. The crickets have

(36) I am indebted to the L. D. S. Church and the officials in the Historian's office for the opportunity to read and use in this study, many notes taken from the Journal History.

(37) Utah Historical Quarterly. Vol. 5, No. 3, p. 91.

(38) Ibid. Vol. 6, No. 1, p. 19.

(39) From Isaac C. Haight's journal, under date of June 4, 1848, we have the following:

"The weather is quite cool and very dry in the Valley. Crops begin to suffer for the want of rain. The crickets have destroyed some of the crops and are still eating the heads of the grain as soon as it heads out. The prospects for grain are discouraging. Many of the Saints begin to think of leaving the Valley for fear of starvation, but I think we need not fear, for the Lord, who, brought us here, is able to sustain us even if our crops fail us. The earth is the Lord's and the fullness thereof."

July 2, 1848, again Haight writes, "The last month has been one of great anxiety to the Saints; the destruction of crops by insects and the discouraging prospects is a great trial to many."

(40) Journal History, June 9 & 21, 1848.

done considerable damage to both wheat and corn, which has discouraged some, but there is plenty left if we can save it for a few days.

"The sea gulls have come in large flocks from the lake and sweep the crickets as they go; it seems the hand of the Lord in our favor. Orrin P. Rockwell has just arrived from California in company with Capt. Davis, and after he rests a few days intends to go to meet you; if so, we will write you again...." From your brethren in the Covenant. (signed) John Smith, President, Charles C. Rich, and John Young, Counselors.

June 21, 1848. "....The brethren have been busy for some time watering their wheat, and as far as it is done the wheat looks well, and the heads are long and large. The crickets are still quite numerous and busy eating, but between the gulls, our efforts and the growth of our crops we shall raise much grain in spite of them. Our vines, beans and peas are mostly destroyed by frost and the crickets; but many of us have more seed and we are now busy replanting and feel assured that we will still raise many pumpkins, melons, beans, etc. Some of our corn has been destroyed, but many large fields look very well and the corn now is growing very fast, as the days and nights are warm, and on the whole we think there is as much good corn growing as we can till and irrigate, though we are still planting early corn...."

On July 17th, Isaac Haight (41) reports that the grain crop was fairly successful and harvesting had commenced.

In 1849 the crops were good, the gulls having attacked the crickets early in the year, there being practically no damage from that source.

A correspondent to the St. Louis Republican sent the following report on Monday, July 16, 1849: "There has been very little sickness in the valley, and very few deaths. It is beyond doubt that this is a very healthy country. There has been a vast amount of labour performed here—extensive farms made, hundreds of houses built, roads made, in addition to ploughing and planting this spring, and it is very encouraging to say that crops look well, and there is no doubt there will be a considerable surplus raised this year; yet, I have no doubt breadstuffs will be high, on account of many of the California emigrants designing to winter here. Wheat will not be less than five dollars per bushel, and corn 1 dollar and 50 cents, or 2 dollars. Many have already commenced harvesting wheat, and it yields well. Five bushels of wheat, will make a barrel of handsome flour as ever was made into bread. Yet the wheat, in many places, will not do as well as was expected, owing to its being sown too late.

"All the crops look exceedingly well so far; and if we had plenty of rain here it would be one of the greatest grain countires in the world. Irrigation makes considerable labour, but when we have all things prepared for it, it will be much less trouble. The crickets have not troubled us any this year. Hundreds and thousands of gulls made their appearance early in the Spring, and as soon as the crickets appeared, the gulls made war on them, and they have swept them clean, so that there is scarce a cricket to be found in the valley.

"We look upon this as one of the manifestations of the Almighty, for the mountaineers say that they never found gulls here till the Mormons came. It was truly cheering to see the flocks of these saviors, extending several miles in length, come from the lake early in the morning, and eating crickets all day,

(41) Haight's Journal. July 17, 1848. Elder Isaac Haight wrote as follows: "The wheat in the Valley is better than was expected. Some of it has already been harvested; it is very short for want of being irrigated in season, yet some is very fine, and the prospects for crops begin to brighten, althoug some of the people have lost their crops by insects and others will be a partial failure. Yet the prospects are that some fine crops of corn and wheat will be raised—enough to sustain the people here. We have great reason to thank the Lord for his mercy towards his people in bringing us to this healthy and beautiful valley. There have been only a few deaths and very little sickness among us since we arrived in this valley, but, notwithstanding this, some of the brethren want to leave and go to some other country."

then at sun down form in a mass, and wing their way to the lake for a night's rest.

"One curiosity about them is, they don't eat the crickets merely to live, but after feeding themselves, they would vomit them up, and go to eating again, and thus continue eating and vomiting throughout the entire day.

"It is a matter of astonishment how fast they will pick them up, and a person could form but a poor estimate of the amount destroyed daily by these winged saviors. Suffice it to say, that about three weeks after the gulls made their appearance, scare a cricket could be seen. This is plainly a miracle in behalf of this people, as the sending of the quails in the camp of the Israelites; and what makes it more manifest is, the fact that, although there were plenty of crickets in the surrounding valleys, where there are no crops, the gulls came by them to the farms, and stayed there till they has cleared them off, although men were at work around them at the time. There has been no damage done by crickets this season."

In 1855 the crickets, notwithstanding the activities of the gulls, so reduced the crops that famine again threatened the fast-growing population of Utah (42). There have been a number of outbreaks of crickets since the pioneer period, in fact in 1938-39, large sums of money was spent by the United States Bureau of Entomology in an attempt to control this same species in Idaho, Colorado, Utah and Nevada. The California Gull still plays an important role in the control of crickets and grasshoppers, feeding mainly upon the pests found around cultivated fields.

The part played by the gulls in saving the crops during the pioneer years, so impressed many of the founders of this State that a movement was started which resulted in the building of the Sea-Gull Monument on Temple Square in Salt Lake City. The unveiling ceremony was held on October 1, 1913. The monument, Fig. 1, consists of a concrete foundation, upon which is a granite base, weighing about twenty tons. From the base rises a round column of granite, fifteen feet high capped by a granite ball. Upon this globe are two seagulls of bronze, covered with leaf gold. The birds weigh about five hundred pounds and measure eight feet across their outstretched wings.

The following is an extract from an address by the Hon. W. W. Riter (43) at the dedication of the monument:

"We have met on this occasion to celebrate, in a modest way, the unveiling of the monument of the Gull, the bird that played so important a part in the

(42) Remy and Brenchley. Ibid. p. 465.

"The year 1855 was not favourable towards the close. The locusts, despite the gulls, had ravaged everything, even the young trees; and the potatoes had been attacked by a destructive insect. The Summer had been unusually dry, and everything was parched up. Famine was imminent; in the month of July flour was sold at eight dollars the hundred pounds. Amid all these trials, a miraculous circumstance, if we are to credit the Mormons, sweetened their pill. During several weeks they collected a substance very like sugar, which covered the leaves of all the trees with a layer the thickness of common glass. Fortunately there was some relief. The locusts had destroyed the first crops, but their ravages having occurred in the early part of the year, there was yet time to sow maize and plant root-crops, so as in autumn to get wherewithal to carry them on, with economy, until the harvest of 1856."

(43) Goddard. The Sea-Gull Monument. Young Woman's Journal. Vol. 24, p. 569, 1913.

preservation of the lives of the Pioneers of 1847 and 1848. It is fitting that the workmanship, or art expression, portrayed in this bird should be the handiwork of a son of the great leader, Brigham Young, who led these early pioneers into this then sterile and forbidding country. I doubt if there are any present to whom this event has a greater significance than to me. I was only a boy of 10 years when the event occurred, which we now have met to commemorate. I well remember the gloom, almost despair, that fell upon us when the crickets came down from the hills in such myriads that the ground was nearly covered with them, and attacked with voracious appetites the then too scanty fields of grain, which had been planted with toilsome hands. You will pardon me if I give you some of my own remembrances in regard to this event, for they are the ones most deeply imbedded in my memory.

"My father had planted eight acres of wheat up there in the Nineteenth ward, on the ground immediately in front of Captain Hooper's old residence. It grew fairly well until the crickets came, and then our glowing hope of a crop was almost turned into despair. My father had put in a rude dam on the north branch of City creek, near where the Odeon now stands, and turned the water to irrigate his wheat down an old channel of the creek until it reached his field. Besides the myriads of crickets which were already devouring the tender plants, this water brought down myriads of others that had come off the hills, and failing to cross the water (for they were a clumsy insect) were washed down into his field. The extremity was so great he offered Robert Pierce the contents of his whole field for three barrels of flour reckoning that these three barrels of flour would feed his family six months, and then we could die.

"The gulls came and gorged themselves on the crickets; once filled they could have given but little relief, for the number of crickets was so great; but the gulls disgorged the masses they had eaten and then continued the process until the situation was saved.

"Brethren and friends, I witnessed this, and relate it to you in all truth and soberness."

A number of references have been made to this episode (44) (45) (46) (47), the most important one from a biological standpoint, with which I am familiar, is a discussion of the Mormon cricket by Dr. W. W. Henderson (48).

Unfortunately there is considerable confusion in the literature as to the species of gull that participated in the destruction of the crickets during the Pioneer Period. The species was, no doubt, the California gull, not the Franklin gull, since the California gull was the common species found nesting on the islands of Great Salt Lake, by Captain Stansbury in 1850 (49). Regardless of the interpretation put upon this incident (50), it has had so profound an influence on the lives of the Mormon people that very early in the history of the State a law was passed protecting the gull. It has also served as a stimulus for the erection of a monument that has attracted international attention.

(44) Henderson, Junius, 1927. The Practical Volume of Birds; p. 126.
(45) Allen, 1930. The Book of Bird Life; p. 264.
(46) Forbush, 1922. The Utility of Birds; p. 21.
(47) Roberts, 1910. Sea-Gull Monument; p. 348, Young Woman's Journal.
(48) Henderson, 1931. Crickets and Grasshoppers in Utah; pp. 1-38, Circular 96, Ut. Agri. Exp. Station.
(49) Behle, 1938. Highlights of Ornithological Work in Utah; p. 166, the Condor, Vol. 40.
(50) Young, 1928. A Story of the Rise of A Social Taboo; p. 449, the Scientific Monthly.

Fig. 1. The Sea-Gull Monument, Temple Square, Salt Lake City, Utah. The only monument ever erected to commemorate the activities of a bird.

STANSBURY'S EXPEDITION TO THE GREAT SALT LAKE

Following closely upon the first government expedition to the Great Basin, conducted by Captain Fremont, was the second one under the command of Captain Howard Stansbury (51). This expedition was organized under the orders of Col. J. J. Abert, and sent to Utah for the purpose of making "a survey of the Great Salt Lake and exploration of its valley." The party reached Utah on August 28, 1849. After spending the winter in Salt Lake City, the party began a survey of the Lake in the spring of 1850, which was completed in time for Stansbury to return to the states just one year to the day from his arrival.

While in the valley of Salt Lake as well as enroute various members of the party collected specimens of plants, a few mammals, birds, reptiles, insects and fossils. Since there was no naturalist appointed, for the expedition, probably most of the collecting was done by Captain Stansbury and Lieutenant Gunnison. All the plant specimens were turned over to Dr. Torrey who lists ninety-three species from Utah. I have listed the plants found upon the Stansbury and Antelope islands. It would be interesting to compare the plant life found upon these islands today, with that of 1850 (52) (53). See Fig. 2.

Plants found upon the following islands in 1850 by Captain Stansbury and Lieutenant Gunnison:

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(51) Stansbury. Explorations and Survey of the Valley of the Great Salt Lake of Utah. 1852.

(52) Jensen, Andrew. 1934. Building of Utah and Her Neighbors. Deseret News, Sat., Oct. 27. Mr. Jensen reports the following from the writings of Mr. Albert Carrington: "On April 19th, 1848, Thomas J. Thurston, Joseph Mount, Madison D. Hambleton, Albert Carrington, Jedediah M. Grant and William W. Potter started at 2 p. m. with a skiff on wheels, for the ford of the Jordan, with a view of exploring the Great Salt Lake and its islands for two weeks." . . . "On the 20th we killed a mud-hen, from which circumstances we named our skiff "Mud Hen." . . . "We did not discover a living thing in the water, but there was water fowl in great abundance. We went aboard again and steered for the first island (Antelope), hauled our boat over a bar one-half mile, and when one and a half, or two, miles off the island, the water again shoaled so that our boat struck bottom. There were several Indian ponies and three Indians in sight on the island." . . . "On the 21st we found the island covered with good grasses; bunch grass prevailing; abundance of starch root; many sunflowers and rose bushes; some sage, a few service-berry bushes, a few willows and some shrubbery in the ravines. A few antelope tracks, one antelope and two prairie hens, were seen." . . . "Steered northwest for a small island (Fremont's Island) and ran aground 400 yards before we reached the shore." . . . "Onion, starch root and wild parsnips plenty; and also some sage and grease bush with much fine rank bunch grass." . . . "We put 150 blue heron and geese eggs aboard, passed on to the north point of the island and landed about sunset on a narrow rocky beach with ledges of gneiss; distance from camp, twenty miles."

These interesting observations on the plants and animals found on some of the islands were made in April, 1848. Mr. Carrington was employed as a surveyor by Capt. Stansbury in 1850, and helped with the exploration of Great Salt Lake and its islands. He was also prominent in surveying during the pioneer days of Utah.

(53) Remy and Brenchley. Ibid. Volume I, Page 179.

"These islands are nine in number, viz.: Antelope, Stansbury, Fremont, Carrington, Gunnison, Egg, Dolphin, Mud, Hat. The largest of all is Antelope Island, which is sixteen miles in length, five in breadth, and rises 3250 feet above the lake; cattle are bred there. The next, Stansbury's Island is twelve miles in length, and twenty-seven miles in circumference. Fremont's Island, which Fremont called Disappointment, and which the Mormons call Castle Island, is fourteen miles in circumference; it has beautiful grass, notwithstanding there is no water. The other islands are much smaller."

Stansbury Island

Corydalis aurea Willd.
Cowania stansburiana Torr.
Spirea Dumosa Nutt.
S. opulifolia var. pauciflora Torr. & Gr.
Heuchera rubescens Torr. (n. sp.)
Aster oblongifolius Nutt.
Monothrix stansburiana Torr. n. g. & n. sp.
Chenactis achilleaefolia Hook. & Arn.
Cirsium undulatum Spring.
Lygodesmia juncea Don.
Crepis acuminata Nutt.
Acerates decumbens Decaisne
Comandra umbellata Nutt.
Triglochin maritimum Linn.
Scirpus torreyi? Olney.
Stipa juncea L.
Elymus striatus Willd.
Calochortus luteus Nutt.
Malvastrum coccineum var. grossulariaefolium (H. & A.)
Phacea mollissima var. Utahensis Torr.
Oenothera albicaulis Nutt.
Mentzellia ornata Torr. and Gr.
Erodium circutatium L'Herit.
Achillea millefolium Linn.
Stunted Cedars

Antelope Island

Sidalcea malvaeflora Gray.
Lupinus albicaulis Dougl.
Gayophytum ramosissimum Torr & Gr.
Juncus balticus Willd.
Eriocoma cuspidata Nutt.
Koeleria cristata Pers.
Hordeum jubatum Linn.
Agropyrum repens Gaest.
Elymus striatus Willd.

The mammals collected upon this expedition were studied by Prof. S. F. Baird, who lists six species from Utah, one of which, the Great-tailed Fox, *Vulpes macrourus*, he describes as new.

Capt. Stansbury and Gunnison collected and observed thirty-one species of birds in Utah. The Mountain Blue bird thought to be new by Baird, was named *Sidia macroptera*. Important notes on the nesting birds found on many of the islands are to be found in Capt. Stansbury's journal notes. For the first time the great nesting colonies of the gulls, pelicans, terns, and herons on the islands of the Great Salt Lake are reported. The eggs of the gull and pelican were used for food, by the surveying parties. Besides the birds reported from Utah, Prof. Baird includes a "List of Birds inhabiting America west of the Mississippi not described in Audubon's Ornithology." One hundred fifty-three species are included in this list.

There were only four species of reptiles collected by the members of the expedition all of which proved to be new to science. These were described by S. F. Baird and Charles Girard as follows: *Cnemidophorus tigris* B. and G., which is considered as a synonym of *C. t. tessellatus* (Say); *Uta stansburiana* B. and G., a new genus and species; *Sceloporus graciosus* B. and G.; and *Coluber mormon* B. and G. Then included along with the report on the reptiles is a "Monographic Essay on the Genus Phynosoma" by Charles Girard. Two species are discussed as occurring in Utah: *Phrynosoma douglassi* Gray and *P. platyrhinos* which Girard described as a new species.

Professor S. S. Haldeman was entrusted with the insects. He reports eleven species from Utah, which includes six new species and

one new genus. It was a difficult matter to get natural history specimens back to the Eastern centers without greatly damaging them.

A letter from T. R. Peale on the larvae of insects found in the Great Salt Lake is included. Mr. Peale reports in part as follows: " In the mass, I can detect fragments of the larvae shells of the pupa, and small portions of a mature *Chironomus* and other Tipulidae. More than nine-tenths of the mass is composed of larvae and exuviae of

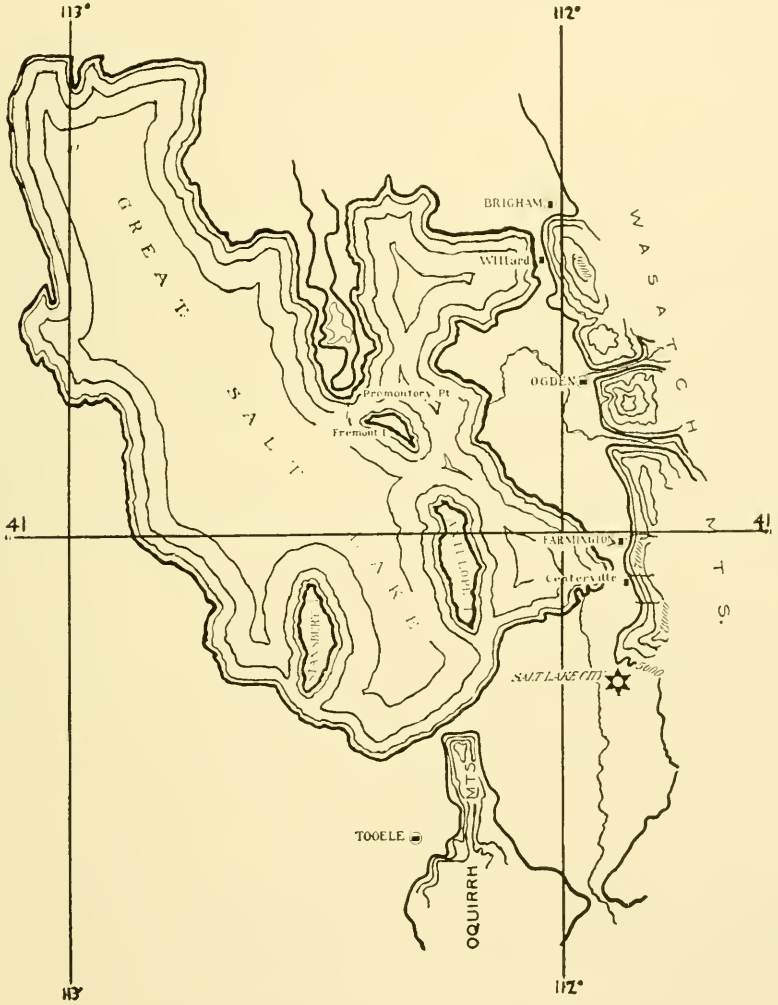

Fig. 2. Map of Great Salt Lake and the three large islands. Antelope, Fremont, and Stansbury.

(From Crawford and Thackwell, Ut. Acad. Sci., Vol. VIII.)

Chironomus, or some species of mosquito—probably undescribed; the fragments being too imperfect to determine."

From a natural history standpoint this was a very important expedition. Baird believed it was the most important since Long's expedition up the Missouri in 1820. One point of interest to the writer is the lack of any mention in Mr. Stansbury's report, of the cricket plague and the part played by the gulls in controlling them.

A THIRD GOVERNMENT EXPEDITION UNDER CAPTAIN J. W. GUNNISON

Captain J. W. Gunnison who played such an important part in Stansbury's expedition was sent back to the west in 1853 in charge of the third government expedition to the Great Basin within ten years. Gunnison was assisted by E. G. Beckwith, in this Pacific Railroad survey work, as well as by such scientific aids as F. Kreuzfeldt, botanist, and Dr. James Schiel, surgeon and geologist. The party after entering Utah crossed the Green River near the present town of Green River City. They then continued westward through the Salina Canyon and on to the desert near Delta, Utah. On October 25, Captain Gunnison, Kreuzfeldt and several other men of the party were killed by Indians on the Sevier River. As a result of this tragedy Beckwith directed the affairs of the expedition which contributed very little to our knowledge of the natural history of the Great Basin (54).

REMY AND BRENCHLEY VISIT UTAH

In the fall of 1855 two French scientists, Remy and Brenchley, who had traveled widely, reached Salt Lake City after a trip of two months, on horse back, from Sacramento, California. So interesting and important are many of the observations made by these gentlemen during their month's stay in Utah, that rather lengthy exerpts are reproduced here.

In February, 1850, the Mormons established by law the University of Deseret, the first university established west of the Mississippi River. A museum was also established for the purpose of teaching as well as handing on to posterity information about the customs of various peoples of the world. It was to house a collection of minerals,

(54) Pacific Railroad Reports. 1855. Vol. II contains an account of this expedition by Beckwith. In Vol. X, 1859, there is a report on the birds of the survey by Baird. Some of the birds taken in 1853-54 are included in this report. Two species of mammals are listed.

plants, animals, and astronomical equipment. Remy and Brenchley have the following to say about the adventure of establishing a museum:

"The Mormons have for some time been occupied by the idea of founding a universal museum. They have already got together a considerable quantity of objects, and their numerous missionaries to all parts of the world materially contribute to their opportunities of forming a very valuable collection. Brigham Young, who thinks this a useful and practical institution, takes a particular interest in its development; but it is much to be regretted that for want of a person sufficiently qualified to direct the collectors and classify the objects, the institution is to this day nothing more than a mere lumber-room of disorder and confusion." (55)

The French scientists not only became conversant with the religious and political affairs of the Mormons, but they traveled about Salt Lake Valley and in the nearby mountains making observations on the plants and animals. The following is a short but good summary of their findings:

"The greater part of the indigenous animals are few, whether as individuals or species, which is to be attributed less to the barrenness of the soil, than to the hunting parties of trappers and Indians. The bison, as we mentioned above, is no longer found to the west of the Rocky Mountains, and the beaver has almost entirely disappeared. Small herds of antelopes (A. furcifer) are to be found in the mountain districts, as well as the American eland (Cervus canadensis), the Virginian deer, the black-tailed deer (C. Lewisii), the black and grisly bear, together with another much smaller species. The mountain sheep (Ovis montana) has become scarce, as well as a carnivorous animal known to the Americans under the much too indefinite name of panther. Foxes, wolves, wolverines (Gulo luscus), are common in the deserts at the foot of the hills. The racoon (Procyon lotor) and the musk-rat (Fiber zibethinus) are often seen on the banks of rivers. Hares are in plenty wherever there is pasturage. Of birds, there are several species of grouse (Bonasia, Tetrao), a sort of pigeon, partridges, eagles, large crows, owls, and curlews. On the banks of the lakes are seen geese, very many kinds of ducks, pelicans, herons, gulls (Larus), large cranes, water-hens (Rallus), and plovers. Nor is there any lack of sparrows on the watercourses and in the thickets. Of reptiles, there are to be found flat-shaped lizards in abundance, and also the rattlesnake. In Lake Utah there is salmon-trout with yellowish flesh, weighing as much as thirty pounds; there are also perch, suckers, pike, rock-fish or striped bass, and bull-heads. Fish is scarcer in the watercourses and altogether wanting in the salt lakes." Volume II. pp. 266-267.

The larger animals, such as the mammals and birds, seemed to attract their attention resulting in 26 species of mammals and 38 species of birds being listed (56).

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(55) Remy and Brenchley. Ibid. Vol. II, p. 188.

(56) Though the Fauna of Utah is as yet very imperfectly known to naturalists, we have no hesitation in regarding it as poor, and of little variety, especially in the lower classes of animals. This poverty is attributable to various causes, among which the most prominent appear to us to be the geographical and hypsometrical conditions of the country, the dryness of the climate, and the barrenness of the soil. We here give a list of mammifers and birds which are with tolerable certainty known to exist in Utah.

MAMMIFERS

Antilocarpa americana. The American antelope.
Canis latrans, Say. The true cayote.
Castor canadensis, Kuhl. The beaver.
Cervus canadensis. The American eland.
. . . Lewisii. The black-tailed deer.

SUMMARY

Students of the natural history of the Great Basin will find the discovery and development of the West most fascinating and profitable. Scattered through the literature are to be found the beginnings, out of which have grown our knowledge of the biota and its environment. Great changes have been made in this environmental complex during the past one hundred years. A number of species have been exterminated, many reduced in numbers and greatly changed in their range, while introduced ones have over-run the basin. The means, by which man has achieved his present status, as "Master of all he Surveys" has been a very questionable procedure. The wastage of animal and plant resources has gone on to such a point that we must recast all policies that affect these resources. A retrospective study, as the one at hand, helps in pointing out ways of dealing with these problems.

. . . virginianus. The Virginian deer.
Cynomys (Arctomys) ludovicianus, Baird. The prairie-dog, or American marmot.
Felis concolor, Linn. The American panther.
Fiber zibethinus, Linn. The musk-rat.
Geomys, (species undetermined.) The American gopher.
Gulo luscus, Linn. The wolverine or glutton.
Lepus. Several species of hares and rabbits imperfectly observed.
Meles labradoria, Sabine. The American carcajou.
Ovis montana, Desm. The mountain sheep or big horn.
Procyon lotor, Storr. The racoon.
Putorius erminea, Linn. The ermine.
. . . vison, Linn. The mink, or minx.
Sciurus. Several species of squirrels not yet well determined.
Ursus horribilis. The grizzly bear.
. . . americanus. Pallas. The black bear.
. . . . . , var. cinnamoneus, Aud. and Bach.
Vulpes macrurus, Baird. Long-tailed fox, confounded with the cayote.
. . . virginianus, Rich. The American grey fox.

Birds

Accipiter fuscus, Bonap.
Anas boschas, Linn. The mallard.
Anser canadensis, Vieill.
. . . erythropus, Linn.
Athene (Strix) hypogaea, Cass. The burrowing owl.
Buteo borealis, Bonap.
Clangula albeola, Bonap. The butter-ball.
Colymbus glaciahs, Linn. The loon.
Cygnus americanus, Sharp. The American swan.
Dafila acuta, Bonap. The duck.
Fuligula affinis, Eyton. The shuffler.
Grus canadensis, Temm. The brown crane, 6½ feet between the tips of the wings.
Larus, species undetermined. The American gull.
Leucosticte tephrocotis, Swains. The finch.
Mareca americana, Steph. The bald pate.
Niphaea oregona, Aud. The snow-bird.
Numenius longirostris, Wils. The curlew.
Otocoris occidentalis, M'Call.
Pelecanus trachyrhynchus, Lath. The pelican.
Phalacrocorax dilophus, Sw. The cormorant.
Peucaea Lincolnii, Aud. A species of American finch.
Pterocyanea Rafflesii, King. The teal.
Querquedula carolinensis, Bonap. A species of teal.
Recurvirostra americana, Gm. The avoset.
Sialia macroptera, Baird. The blue bird.
Sternella neglecta, Aud. The lark.
Symphemia semipalmata, Hart. The willet.
Tetrao urophasianus, Bonap. The prairie hen; grouse. Vol. II, pp. 527-528.

In this study we have discussed the discovery, character, and extent of the Great Basin.

The history of the buffalo in Utah is summarized. The Mormon cricket-California gull episode is reviewed and some original source material is included from the Latter-day Saint Church Journal History.

The plants and animals found, in Utah by government exploring parties led by Fremont, Stansbury and Gunnison, are discussed. Remy and Brenchley visited Utah in the fall of 1855 and made many observations on the natural history of the Great Basin. Their visit and observations are briefly reviewed.

Bunch grass and sparsely scattered sagebrush were common on the islands of Great Salt Lake and in the Utah, Salt Lake, Ogden and Cache Valleys of Utah.

By the end of the year 1855, 101 plants; 611 insects; 6 fish; 7 amphibians and reptiles; 113 birds; and 93 mammal species were known to occur in the Great Basin. Utah was the type locality for 13 plants; 6 insects; 4 reptiles; 1 bird; and 2 mammal species.

Spongilla fragilis Found in Utah Lake and Salem Pond

The sponge *Spongilla fragilis* Leidy was known from only one locality in Utah prior to October, 1939, when it was collected at the Brigham Young University Lakeside Biological Laboratory, on the mouth of Provo River. It was found to be rather common forming fairly larger growths on the willows and tree branches which have fallen in the river. This species was previously reported, by this writer, as occurring in Salamander Lake, on Mt. Timpanogos, in the Proceedings Utah Academy of Sciences, Vol. IX, 1932, pp. 113-115. Another sponge *Spongilla lacustris* (L.) known from Utah, also occurs in Utah Lake. *Spongilla fragilis* was also collected in Salem pond, 15 miles south of Provo, on Jan. 18, 1940, by Dr. D. E. Beck and students. Large specimens 10 to 12 inches in diameter were removed from the bottom of the pond.—V. M. T.

Dr. Pfouts Contributes Butterflies

A rather representative collection of the butterflies of Utah County, taken at Payson and in Payson Canyon by Dr. L. D. Pfouts, dentist and amateur naturalist, has been contributed to the Entomological Collection of the Brigham Young University. This collection consists of 63 species and 730 specimens. Fourteen specimens are topotypes of the new species *Argynnis pfoutsi* Gund. This collection is a welcome one, adding materially to the Tom Spalding collection of Utah butterflies and moths which consist of more than 700 species.—V. M. T.

DR. HENRY CLINTON FALL (1862-1939)

With the passing of Dr. Henry C. Fall, students of the Coleoptera lost one of their outstanding colleagues and authorities.

Dr. Fall was born at Farmington, N. H. on December 25, 1862. He received from Dartmouth College the degrees of Bachelor of Arts in 1884 and Doctor of Sciences in 1929. He died at Tyngsboro, Mass. on November 14, 1939.

Because of his health, he early went to Southern California where he began his serious study of the Coleoptera. For more than forty-five years Dr. Fall was a contributor to the literature on this group. Students of the west coast are greatly indebted to him for his careful studies of the beetles of this region. The paper, *A List of the Coleoptera of Southern California*, published in the Occasional Papers of the California Academy of Sciences in 1901, pages 1-282, will long be of service to Entomologists of the Pacific Coast. Dr. Fall was not only a careful student of the Adephaga and Polyphaga, but he contributed much to our knowledge of the Rhynchophora. His papers, *Revision of the Species of Apion of America North of Mexico; A Brief Review of our Species of Magdalis with Notes and Descriptions of Other North American Rhynchophora; New North American Species of Apion and Apteromechus; and New Species of American Coleoptera of the Tribe Zygopini*, are indispensable when studying the weevils. Dr. Fall described 1,400 new species of Coleoptera of which 185 were weevils.

I had the privilege of visiting with Dr. Fall when I was at Tyngsboro, Mass., on August 5, 1928. His home which is typically New England in style, is on a little hill, surrounded with white pines, and overlooking the Merrimac River. He owned the home in which the noted Coleopterist Frederick Blanchard lived and died. I was received in a very cordial manner, being permitted to see specimens from many families and when I left I was given a box containing 83 species of beetles in which I was interested. I was impressed with the way he cared for his large collection. Everything was in order, the specimens were neatly mounted and arranged in Schmitt boxes. It was also of interest to see how accurately he studied his specimens with a small pocket lens. At this time he was greatly handicapped in his work because of poor health. Two years before my visit he had an operation on his right eye for an abscess. This had never healed up, it being necessary to dress it several times a day. This affected his sight and made his work extremely difficult. He informed me that his collection, which is one of the most important private ones in this country, would be deposited in the Museum of Comparative Zoology at Harvard University.

Coleopterists of the future will find Henry C. Fall's name inscribed along with LeConte's, Blanchard's, and Bowditch's when they frequent the cabinets and laboratories containing the thousands of specimens of Coleoptera that have been named and passed on to posterity by these masters.—V. M. T.

A PRELIMINARY HISTOLOGICAL STUDY OF THE OVARY OF THE KANGAROO RAT DIPODOMYS ORDII COLUMBIANUS

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INTRODUCTION

The kangaroo rat, *Dipodomys ordii columbianus* Merriam, is a member of the Heteromyidae, and is well represented in the semi-arid portions of the central Utah region of the Great Basin.

The literature dealing directly with Dipodomys appears to be rather limited. Grinnell (1919, 1922, 1929) has described the geographic distribution of Dipodomys and some new species from California. Vorhies and Taylor (1922) published a paper dealing with the life history of the genus. The implantation of the blastocyst was studied by Lee (1918), and a brief analysis of the placentation and fetal membranes was published by Mossman (1937 a). Midgley (1938) described the visceral anatomy from a comparative point of view. Other papers dealing with this group may have been published, but I have seen only those mentioned. In this paper a preliminary histological study of the kangaroo rat ovary is described.

MATERIAL AND METHODS

The material consists of the ovaries of 42 animals. Thirty of the specimens were taken alive, while 12 were dead in the traps. Although a year-round collection is highly desirable for a study of this kind, only animals taken during January (19 animals), March (1 animal), April (2 animals), June (1 animal), July (3 animals), August (1 animal), and September (15 animals) have been available for study.

All the ovaries, with the exception of two sets, were fixed in Bouin's fluid. The two exceptions were fixed in Allen's B-15 modification of Bouin's fluid. Most of the ovaries were sectioned at seven micra, although some were cut at ten. Sections were mounted serially and stained with hematoxylin (both Delafield's and Ehrlich's) and eosin.

I wish to thank Dr. Vasco M. Tanner of Brigham Young University, Provo, Utah for sending me the ovaries of 18 of the animals. The animals were collected about two miles northwest of Provo, Utah.

OBSERVATIONS

General Description. The ovary of Dipodomys is small (1.3 x 1.3 x 1.9 mm.) and is non-lobulate. It is covered by a very thin germinal epithelium whose nuclei are similar to those of mesothelial cells. In some ovaries small groups of cells of the germinal epithelium penetrate the thin tunica albuginea, and some of their nuceli are enlarged. Here and there oocytes are to be seen with their outer surfaces flush with the surface of the germinal epithelium (fig. 1).

The peripheral region of the ovary, below the tunica albuginea is usually occupied by a varying number of oocytes and growing follicles. The oocytes may occur singly or in nests of two or more (fig. 2). Follicles in which the granulosa is made up of several layers of cells are usually found deeper in the ovary than are the smaller follicles, although both large growing follicles and Graafian follicles are to be found relatively near the surface.

Unless degeneration overtakes a follicle the mature Graafian follicle frees its ovum into the oviduct by the process of ovulation. Some or all (the origin of the corpus luteum is beyond the scope of this paper) of the remaining cellular layers of the ruptured follicle are modified into the lutein cells of the corpus luteum. If degeneration occurs in any follicle in which the thecal layers are differentiated, the cells of the theca interna metamorphose into the interstitial cells of the ovary. Between the follicles are found spindle-shaped stroma cells, interstitial cells, and fibrous connective tissue containing blood vessels.

The Growth of the Follicles. The primary oocytes usually lie in the outermost part of the cortex. They are small (13-18 micra in diameter) with a round, centrally located nucleus (10-12 micra in diameter). The oocytes are naked, as a rule, excepting for one or two small fibroblastic-like nuclei which lie against the cell membrane. Oocytes are found: (a) immediately below the germinal epithelium; (b) within the tunica albuginea; and (c) below the tunica in the cortex. Throughout this paper the follicles will be designated as types 1, 2, 3, and Graafian follicles.

Follicles of type 1 are as a rule found below the tunica albuginea, although in some instances they have been seen just beneath the germinal epithelium. The ova of such follicles have a diameter of 16-26 micra with a centrally located nucleus approximately 12 micra in diameter. The ova are surrounded by one complete layer of cubic epithelial cells, resulting in a follicle of 26-48 micra in diameter. Occasionally, especially in the larger follicles of this type, a rather deli-

cate zona pellucida is seen around the ovum and also a basement membrane can be seen between the follicle cells and the stroma.

The ova and nuclei of type 2 follicles are larger than those of type 1. The follicular diameter measures 52-68 micra, the ova 26-48 micra, and the nuclei 12-18 micra in diameter. One complete layer of follicular cells is always present and the beginning of a second layer is not uncommon. The nucleus is still in a central position within the ovum. The zona pellucida and the basement membrane of the follicle cells are more distinct in this type (fig. 3) than in type 1. External to and contiguous with the basement membrane are small fibroblastic cells and delicate fibres derived from the stroma. These cells and fibres are the anlagen of the future thecal layers. Type 2 follicles are usually located beneath the tunica albuginea.

Type 3 follicles are always situated beneath the tunica albuginea and are usually rather deep in the cortical region. The ova of these follicles are much larger than those of type 2, being 52-68 micra in diameter. The nucleus is also larger, 23-37 micra in diameter, and as a rule occupies an eccentric position in the cytoplasm of the ovum. Follicles of this type possess from three to nine or more layers of follicle cells in the stratum granulosum. The increase in number of follicle cells is the result of mitosis for different stages of the division process are quite common, not only in type 3 follicles, but of types 2 and 1 as well. The zona pellucida is very distinct in most follicles of this type and both thecal layers are present. The cells of the theca interna are larger and oval, or even round, while those of the theca externa are spindle-shaped. Mitoses are common in cells of the theca interna, and tiny blood vessels vascularize the layer.

The Graafian follicles contain ova of about the same size (52-70 micra in diameter) and appearance as the preceding type. One or several fluid-filled antra of varying sizes are located in the stratum granulosum. All stages of mitosis are to be seen in the follicle cells. The theca interna of many Graafian follicles is a thickened and distinct structure in comparison to the theca externa of the same follicles. The ratio of cytoplasm to nucleus is much greater in cells of the theca interna than it is in the theca externa, and the nuclei of the former are large and oval or round while those of the latter retain their resemblance to the stroma cells, with which they imperceptibly merge. The vascularity of the theca interna is more apparent in this type than it is in type 3 follicles. A comparison of the diameters of ova and nuclei of the various follicular types is shown in fig. 7.

Follicular Atresia. Any of the above mentioned follicles may degenerate by the process of atresia. In general all the component parts of a follicle undergoing atresia ultimately atrophy. But that part of the follicle in which atresia is first recognizable is variable. Table I indicates the amount of atresia observed in each ovary.

In some follicles (types 1 and 2 as a rule) the ovum seems to be the first part of the follicle to exhibit signs of atresia. The cytoplasm of the ovum shrinks away from the granulosa cells, thus giving the ovum a shrunken, irregular appearance. The nucleus also becomes irregular in shape and may disappear, leaving a hyalinized contorted mass which stains heavily with eosin. The granulosa may remain intact (fig. 4), or it may disintegrate and some of its cells invade the degenerating ovum.

In other follicles (Graafian, and usually those of type 3) the first recognizable signs of atresia are generally seen in the follicular cells and not in the ovum. The cells of the stratum granulosum immediately surrounding the ovum pull away from the ovum, their nuclei become pycnotic, and these pycnotic cells frequently invade the follicular cavity (fig. 6).

The first maturation spindle may form in the ova of atretic follicles of type 2 and 3 and Graafian follicles. Occasionally in the latter the first polar body may be formed (figs. 5 and 6). The fate of the thecal layers of atretic follicles will be considered in the following section.

Interstitial Cells. In many ovaries, surrounding atretic follicles and scattered throughout the stroma, are masses or blocks of cells which I have called interstitial cells. The amount of this tissue within an ovary varies, being practically absent in some and very abundant in others.

These patches or blocks of interstitial cells appear under low power as rather homogenous light-stained areas containing several nuclei. With high power, or better still with oil immersion, the cytoplasm appears more or less vacuolar, cell membranes are very faint and often absent, and the shape of the nuclei varies from a smooth oval or round contour to an irregular, crenated-appearing contour.

The interstitial cells originate from the theca interna of atretic follicles. In some atretic follicles the theca interna has lost the appearance characteristic of normal follicles—the cell walls have disappeared, the cytoplasm has become more vacuolar and has little or no affinity for eosin, and the nuclei have a crenated or irregular shape.

That the presence of these interstitial cells may be cyclic or periodic is suggested by the varying amounts in which they are found in the various ovaries. Table I gives the relative amount of interstitial cells in each ovary.

EXPLANATION OF TABLE I

It is realized at the outset that the survey summarized in this table is superficial and possibly inadequate. Yet it will serve as a basis for comparison of the animals making up the collection here studied.

These counts are of one section, as near the central portion of the ovary as could be determined, for each animal. The data on the oocytes and follicles and corpora lutea are more accurate than that on the interstitial cells, since the follicles, corpora, etc. could be counted, while in the case of the interstitial cells only an estimate could be made since no way has been found to make a quantitative study of them.

TABLE I

Specimen No.	Date taken	No. oocytes	No. foll.	% Foll. atretic	Corp. lut.	Inst. cells	Stage of preg.
78	1/16	13	15	47%	..	**	.....
79	1/16	16	29	41	..	**	.....
80	1/17	5	27	52	..	***	.....
81	1/17	28	11	45	2	**	.....
82	1/17	18	17	41	..	**	Bilaminar blastocyst
83	1/17	51	11	9	..	**	.....
84	1/18	43	23	48	..	**	.....
85	1/18	45	12	17	..	***	ovulation
86	1/18	65	16	44	..	**	.....
87	1/18	104	11	36	1	*	Bilaminar blastocyst
88	1/18	31	26	50	..	**	.....
89	1/22	11	22	59	..	***	.....
90	1/22	42	19	21	..	**	.....

TABLE I (cont.)

Specimen No.	Date taken	No. oocytes	No. foll.	% Foll. atretic	Corp. lut.	Inst. cells	Stage of preg.
91	1/22	13	22	36	..	**	.....
92	1/22	19	23	30	..	**	.....
93	1/22	57	10	40	1	***	11 mm. embryos
94	1/22	15	14	71	1	**	5 mm. embryos
95	1/22	44	14	64	2	***	.....
96	1/22	67	26	42	2	**	.....
12	3/10	6	10	30	2	**	.....
97	4/5	62	11	36	..	***	.....
98	4/5	19	27	37	..	***	.....
70	6/5	Tissue unsuited for study					13 mm. embryos
74	7/2	5	3	0	1	**	.....
68	7/10	108	29	38	..	*	.....
1	7/30	52	9	11	..	**	.....
3	8/20	4	5	20	..	***	.....
69	9/1	..	14	50	..	***	.....
76	9/2	14	7	57	..	***	.....
77	9/3	5	9	44	..	**	.....
75	9/4	13	11	18	..	**	.....
72	9/7	25	17	65	..	***	.....
71	9/8	Tissue unsuited for study					
73	9/8	42	15	40	..	**	.....
4	9/15	18	18	22	1	**	8 mm. embryos
5	9/21	4	16	69	2	***	Bilaminar blastocyst
6	9/21	88	10	30	1	***	Stage unknown

TABLE I (cont.)

Specimen No.	Date taken	No. oocytes	No. foll.	% Foll. atretic	Corp. lut.	Inst. cells	Stage of preg.
7	9/22	85	8	0	1	**	.....
8	9/22	32	20	45	2	***	16 mm. embryos
9	9/22	81	21	19	..	**	15 mm. embryos
10	9/22	6	8	13	2	***	22 mm. embryos
11	9/22	41	5	60	..	***	.....

DISCUSSION

It is not the purpose of this paper to discuss the literature dealing with ovarian histology and cytology, since that has been adequately done by several workers. The reader is referred to Corner's discussion and bibliography in Cowdry's Special Cytology (1932).

Post-natal and post-pubertal ovogenesis in mammals is still a field for intensive investigation. Hargitt (1930 a and b) is convinced that there is a continuous production of germ cells from the germinal epithelium of the ovary of the albino rat throughout the reproductive period. Mossman (1937 b) and Pliske (1938) have indicated that the same is true in the pocket gopher and thirteen-lined ground squirrel. Mossman's paper is more a suggestion than a verified conclusion of post-pubertal ovogenesis, since he deals with ovogenesis only incidentally to a study of the so-called thecal gland. On the other hand, Pliske's study on the ground squirrel deals directly with the problem of the follicular cycle, and he concludes that the process of ovogenesis continues in the adult. Both the type of germinal epithelium and tunica albuginea of the ovary of Dipodomys suggest this animal as a possible type for such a problem if the difficulties of determining the age of specimens and of making large enough collections can be overcome.

The term "interstitial cells" is one more of convenience than anything else. This is due (1) to the fact that the interstitial cells of the ovary constitute a point of controversy, different investigators differing in their conception of the term, and (2) the material used for this study was not fixed for cytological study.

It would be worth while to study thoroughly the cytology and fate

of these cells. As has been mentioned before, they appear to be cyclic or periodic in nature. The number of these cells in any one ovary varies; their degree of vacuolation varies; in some ovaries their cell membranes can be seen while in others they cannot; and in some ovaries the nuclei of these cells are rather smooth in outline, while in others they are very irregular. It is known that some other mammals exhibit a cyclic production of interstitial cells; Rasmussen (1918) and Guthrie and Jeffers (1938) found this to be the case in the woodchuck and bat respectively. However, any similarity between the woodchuck or bat and the kangaroo rat in this respect would be limited, since the interstitial cell cycle in the woodchuck and bat is correlated with hibernation, which in turn affects the reproductive cycle. Evidence from this study indicates that the kangaroo rat does not hibernate, viz., different stages of pregnancy have been found in January, March, June and September (see Table I). Then, too, Table I seems to show no correlation between the number of interstitial cells present and the time of year the animal was collected. All this would seem to argue strongly for year-round activity, which in turn would have its effect upon the reproductive cycle.

Although the ovary of the kangaroo rat is probably quite similar to that of other rodents, yet it seems that the study of a complete cytologically fixed and well prepared collection might possibly yield some light on points that are now controversial.

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EXPLANATION OF FIGURES

Figures 1-6 were drawn with a camera lucida at the magnifications indicated.

List of abbreviations:

bm . . . . basement membrane
f ep . . . follicular epithelium
ge . . . . germinal epithelium
ms . . . . maturation spindle
nu . . . . nucleus
oc . . . . oocyte
ov . . . . ovum
p b . . . . polar body
p f ep . . pycnoctic follicular epithelium
th . . . . undifferentiated thecal layers
zp . . . . zona pellucida

PLATE I

Figure 1. Oocyte just below germinal epithelium. x 970.
Figure 2. Nest of four oocytes beneath the germinal epithelium. x 970.
Figure 3. Follicle of type 2. The zona pellucida and basement membrane are both clearly differentiated. x 970.
Figure 4. Atretic follicle of type 2. The ovum is hyalinized and shrunken. Granulosa layer (f ep) is intact. x 430.
Figure 5. Ovum of atretic Graafian follicle, showing first polar body. x 430.
Figure 6. Ovum of an atretic follicle of type 3. Pycnotic cells of follicular epithelium have become loosened and pulled away from the ovum. Maturation spindle is present. x 430.
Figure 7. Chart showing the relationship of nuclear diameter to ovum diameter in follicles of types 1, 2, 3, Graafian follicles, and oocytes.

Plate I

A STUDY OF THE OVARY OF THE KANGAROO RAT by KENNETH L. DUKE

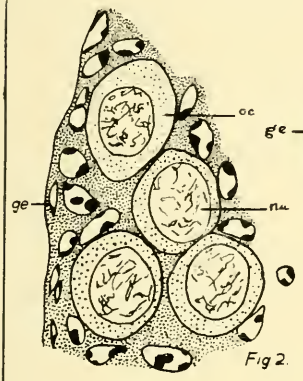

Fig 2.

Fig. 1

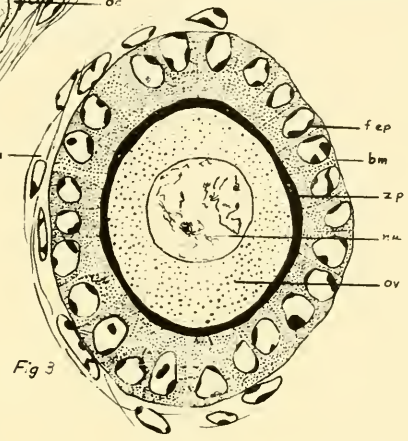

Fig 3

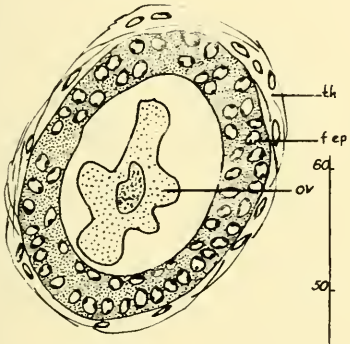

Fig. 4

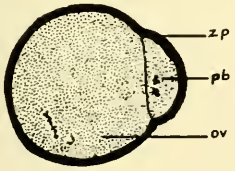

Fig. 5

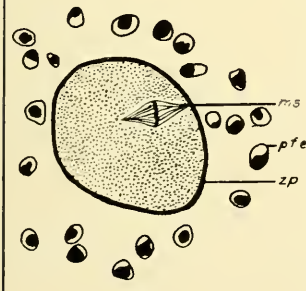

Fig. 6

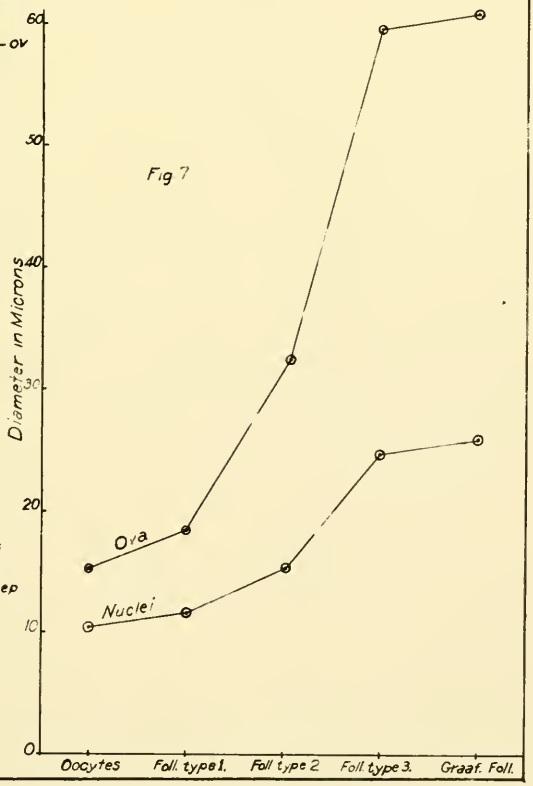

Fig. 7

THE ESTABLISHMENT AND MAINTENANCE OF TERRITORIES BY THE YELLOW-HEADED BLACKBIRD IN UTAH [1]

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INTRODUCTION

Fragmentary and incidental observations on the life-history of the Yellow-headed Blackbird *Xanthocephalus xanthocephalus* (Bonaparte) date back to 1825 when Prince Charles Lucien Bonaparte first described and figured this species in his "American Ornithology." Observations on this species have since been made by many American ornithologists including Audubon (1842); Coues (1871); Baird, Brewer, and Ridgway (1874); and Bendire (1895); but no really serious effort was made to study its life-history until 1909 when T. S. Roberts kept a colony consisting of sixty-two nests under observation for a period of thirty-two days. Since that time other short but careful studies on the nesting habits of this bird have been made by Gabrielson (1914) in Iowa and Nebraska, by Wetmore (1920) in New Mexico and by Linsdale (1938) in Nevada. In spite of all observations the establishment and maintenance of territories was not noted until 1932-34 by Linsdale, the results of whose observations were published in 1938.

During the spring and summer of 1937 the writer had the opportunity of studying two colonies of Yellow-headed Blackbirds in Utah, studying them from the time they arrived in the spring until they migrated in the autumn. Both colonies were located about five miles west of Provo, Utah, in the vicinity of Utah Lake. The larger of the two colonies was designated as the "Provo River Colony" because it was located at the mouth of the Provo River on the east shore of Utah Lake. The other colony was designated as the "Lakeview Colony" and was located northeast of the Provo River Colony about two miles east of Utah Lake.

Because of the height and density of the vegetation in which the Provo River Colony was situated it was difficult to identify particular

(1) Contribution No. 79, from the Department of Zoology and Entomology, Brigham Young University and the Departament of Zoology, University of Illinois.

individual birds and to determine the boundaries of their territories. consequently the writer's observations on the establishment and maintenance of territories were largely restricted to the Lakeview Colony, the location of which offered many distinct advantages for a study of of this kind. This colony was very favorably situated in a low depression surrounded by higher ground and open pastures so that the entire area could be viewed from any one position around its border. The size of the area restricted the number of birds present and consequently greatly facilitated the identification and study of individual birds and made possible the determination of the boundaries of each territory.

DESCRIPTION OF COLONIES

The Provo River Colony occupied an area 2 hectares (5 acres) in extent which was covered by a dense growth of tamarix *Tamarix gallica* L. and willows *Salix* ssp. varying in height from 4 to 12 feet and growing in water 5 to 19 inches deep. The Lakeview Colony occupied a small marsh lying in a low depression into which water drained from the surrounding fields and pastures. The area occupied by this colony was 0.15 hectares (0.37 acres) and was covered with a dense growth of bulrushes *Scirpus validus* Vahl. and some sedges *Carex* ssp. which were growing in water whose depth varied from 9½ to 30 inches.

As indicated by the difference in the kinds of vegetation occupied by these two nesting colonies and since this same species was also found nesting in cattails *Typha latifolia* L. in other places around the lake, it would seem that the species of vegetation is of little concern to this bird in its selection of nesting sites. This fact is also substantiated by various other observers who have reported the Yellow-head as nesting in many different kinds of vegetation: bulrushes *Scirpus*, Roy (1903); flags *Iris*, Bent, (1908); reeds *Phragmites*, Roberts (1912); sedges *Carex*, Kumlien (1897); cattails *Typha*, Healy (1917); and willows *Salix*, Linsdale (1938).

No territories were established in areas where the vegetation was not growing in water. Williams (1929) in northeastern North Dakota, Davis (1935) in Idaho, and Stephens (1937) in Iowa all cite evidence of the Yellow-head failing to breed in areas from which the water had disappeared even though there was sufficient moisture to support the plants and although the birds had previously nested in the areas when water was present.

ESTABLISHMENT OF TERRITORIES

The first Yellow-heads to arrive made their appearance April 5, 1937, in the vicinity of the Provo River nesting area. This flock consisted of 9 mature males which were not found in the area where the colony was later established but were in the tamarix along the lakeshore about an eighth of a mile south of the mouth of the Provo River.

One week later, April 12, 3 males were seen in the Provo River nesting area. By April 18, when the spring migration of males was at its height, this area was occupied by 250-300 male Yellow-heads and about an equal number of male and female Red-winged Blackbirds *Agelaius phoeniceus* ssp. At this time there was no evidence of the Yellow-heads having begun the establishment of territories because both species flocked together and there was no segregation or isolation of individual males.

Following this influx of male Yellow-heads there was a gradual decrease in their numbers until by May 1, only 20-30 birds remained. At this time there was no flocking and the remaining males were well distributed over the nesting area. The Yellow-heads had also become so intolerant of the Red-wings that no Red-wings remained in the area. Some later Yellow-head arrivals also established territories in this area so that by the time the peak of the nesting season was reached the male population amounted to 25-35 birds.

No Yellow-heads were observed in the Lakeview area until April 25, three weeks after the first males appeared at the Provo River area. At this time 12 males were present, some having already established their territories. Although the males of the Lakeview Colony arrived somewhat later than those of the Provo River Colony, they began the establishment of their territories immediately so that the establishment of territories began at about the same time in both colonies.

Although as many as 20 males were sometimes seen in the nesting area of the Lakeview Colony during the early part of the breeding season, only 12 established territories. The first males to arrive selected those parts of the marsh where the previous year's growth of bulrushes was most dense and consequently best suited for the attachment of nests. The later arrivals established territories around the edge of the marsh outside the territories of the early arrivals. A small part of the marsh which had been burned over so that the bulrush stumps extended only 6 to 8 inches above the surface of the water was not occupied until all the other available parts of the nest-

ing area had been claimed (Fig. 1). This was the last territory to be established and in which the last nest was constructed.

The size of the individual territories varied considerably and seemed to be limited by competition for space and the suitability of the habitat for nesting purposes. The territories were smaller and more numerous in the more favorable than in the more open parts of the marsh. The twelve territories of the Lakeview Colony varied in size from 760 square feet to 2,275 square feet with an average of 1,294 square feet (Fig. 1).

No first year males established territories or were observed within the nesting area although they were frequently observed in adjacent areas.

POPULATION OF THE TERRITORIES

The males arrived early enough so that many of them had already established their territories by the time the females made their appearance. The first females to arrive at each of the nesting areas were observed about two weeks after the arrival of the first males and at the time when the male migration was at its height. The first females were observed at the Provo River area, April 18. By April 25, the female population of this area had increased to 70-100 birds and one week later was estimated to be 150 although this number did not remain and nest in the area. The first females to arrive at the Lakeview area were observed May 5. Five females were seen at this time and two days later the number had increased to 14. The total female population of 40 birds was reached about June 5, which together with the 12 males made a total population of 52 birds or slightly over 4 birds per territory.

Each territory was occupied by a single male and from one to five females, however any one particular territory was not occupied at the same time by the total number of females which occupied it during the entire season, but due to a prolonged nesting season and disturbances of various kinds, certain females occupied a particular territory at one time and others at another. There were three territories in which four females nested at the same time; six in which three nested; two in which two were present at the same time; and one in which only one female was present at any one time. A few females made second and third attempts at nest building so that the 44 nests represented in figure 1 were constructed by 40 females.

MAINTENANCE OF TERRITORIES

During the process of establishing and maintaining their territories the males made themselves as conspicuous as possible by displaying themselves from the highest perches within their territory and by singing. This performance seemed to be a means of attracting the females that were seeking places to build nests and also served as a means of protecting their territories by notifying and warning other males that the particular area was occupied. With one foot placed above the other or in a straddled position with one foot grasping one stem and the other another as near to the tips of the slender tamarix and bulrush stems as would support their weight the males would sway back and forth in the breeze and would do their best to produce a song, which, though far from being musical, could not help but attract attention.

The display which accompanied their singing consisted of a peculiar twisting of the neck, a fluffing out of the feathers, a spreading of the tail and a holding of the wings slightly out from the sides of the body so that their white patches became very conspicuous. During the course of the song the neck was stretched forward and downward and then gradually raised so that by the time the climax of the song was reached the beak was almost pointing skyward.

The song of the Yellow-head is very difficult to describe because it is so unmusical and mechanical and because it would probably be interpreted somewhat differently by everyone who heard it. Taverner (1934:371) describes the singing activities of this bird in the following vivid manner: "The song of the Yellow-headed—if song it can be called, as it lacks every musical quality—is like that of no other Canadian bird. Climbing stiff-leggedly up a reed or tule stalk, the male, with wings partly raised, lowers his head as if about to be violently ill, and disgorges a series of rough, angular consonants, jerkily and irregularly, with many contortions and writhings, as if their sharp corners caught in the throat and they were born with pain and travail. They finally culminate, and bring satisfied relief in a long-drawn, descending buzz, like the unwinding and futile running down of the machinery. The general effect of the performance may be somewhat suggested by the syllables—'Klick-kluck-klee-klo-klu-klel-kriz-krizzzzzzeeeeeee.'"

The males did some singing when they first arrived but it became much more pronounced after they had established definite territories.

The boundaries of the territories were recognized and closely ad-

hered to by both the "owner" of the territory and by his neighbors. While in his territory the male was ever on the alert to guard it and chose the highest perch possible from which to watch over his domain. One particular male had three perches around the periphery of his territory whose boundaries he would partol by flying from one perch to another at frequent intervals.

The boundaries of individual territories were determined by the activities of the males, which included not only singing and display but also fighting. Whenever one male happened to enter another male's territory he was immediately attacked by the owner and driven out. On no occasion was the intruding male seen to resist expulsion by the "owner" but in all cases immediately retreated. If the retreating male's territory joined that of the pursuing male he would stop after reaching his own territory and resist further pursuit by the other male. Usually the pursuing male would also stop and return to his perch but on some occasions, especially during the early part of the season when territories were just being established, the pursuing male would continue his chase and a battle would ensue. Thus the points at which the retreating males resisted further chasing and where the pursuing males stopped or engaged in combat with the other males were used as an indication of the boundary lines of the individual male territories.

Some feeding was done within the territories, especially during the early part of the nesting season, but the Yellow-heads obtained most of their food outside the nesting area. Feeding within the territory was much more prevalent in the Provo River Colony where there was an abundance of midges *Chironomus* on the vegetation than in the Lakeview Colony, where most of the feeding was done in the adjacent pastures and fields and where at frequent intervals during the day the males left their territories to forage. Several of them usually left the nesting area together and when outside the confines of their respective territories seemed to lose most of their intolerance, feeding very complacently together. Since most of their feeding was done outside the nesting territories the amount of time spent within the territories was reduced considerably and varied with different individual birds and with different parts of the nesting season. The average percentage of time spent within the territories during the day was forty-five. This was shortly after the territories had been established and when mating activities were at their height.

On a number of different occasions when one male left the nest-

ing area and his neighbor remained, the remaining male would assume temporary dominion over both his own territory and his neighbor's until the return of the rightful owner. If some male other than the owner tried to invade either of these territories, he was immediately driven out.

Most of the males maintained their territories until about the time they began to moult but some of them had abandoned their territories by June 1. Just prior to the time the first males left their territories, a cold rain storm occurred, May 30, accompanied by a strong wind which destroyed many nests and caused the death of many nestlings. Whether this storm was responsible for the early abandonment of some of the territories by the males is difficult to say, but it would appear that the storm may have had some influence.

After some of the males had deserted their territories the remaining males appropriated the abandoned territories adjoining their own so that the original twelve territories of the Lakeview Colony were occupied by seven males during the latter part of the nesting season, (Fig. 1). In figure 1 the original 12 male territories are indicated by solid boundary lines and numbered in the order of their establishment. Broken lines are used to indicate the expansion of certain territories (numbered with Roman numerals) after others were deserted. The boundaries of territories 4 and 5 remained unchanged throughout the season. The males that remained longest were those within whose territories the late nesting females occurred.

Although very intolerant of each other within the confines of their personal territories, the males were very cooperative in times of danger. Whenever any member of the colony, male or female, emitted an alarm call, all the other members of the colony immediately responded and often flew to the place from which the alarm was sounded. Here in the presence of a common enemy they would enter into the combat in a most cooperative spirit. After the intruder had been expelled from the nesting area the males would return to their respective territories and reassert their intolerance for each other.

The females seemed to exercise dominion over a small area immediately surrounding their nests but did not recognize the boundaries of the male's territory in which they nested. As previously described, several females nested in the same male's territory, and although the different females in a few cases constructed their nests less than a meter apart, yet they were generally intolerant of each other in the vicinity of their own nests and more frequently occupied opposite

extremities of the same male's territory (Fig. 1). When one female approached within two or three feet of another female's nest the owner of the nest would immediately attack the intruder driving her away from the immediate vicinity of the nest but not necessarily out of the male's territory within which she was nesting. At no time were the females observed to help the males defend their territories.

The young fledglings and their mother usually remained relatively close to the nest for several days after leaving it but eventually made their way into territories other than the one in which they were hatched. There was no evidence of the males objecting to this but in most cases the territory which the fledglings entered had been abandoned by the original "owner."

RELATIONSHIPS WITH OTHER SPECIES

Linsdale (1928) has pointed out that the nesting habits of different species of birds are sufficiently varied so that they may occupy the same general area and yet not be competing with each other for nesting sites. The idea that each species of animal has a particular niche in nature into which it fits is generally true, but the more closely related the species are, the more similar the niches into which they fit usually become, so that in some cases there may be very marked competition for these niches. Such seems to be true in the case of the Yellow-headed and Red-winged Blackbirds. As previously mentioned the Red-wings flocked with the Yellow-heads at the time of spring migration, before the Yellow-heads had established their territories, and they also flocked together in the late summer and autumn after the nesting activities were over but they were incompatible during the nesting season. The Yellow-heads were restricted to vegetation growing in water yet the Red-wings very often preferred this same type of habitat. Five pair of Red-wings nested in the Lakeview area but none of them were in the immediate vicinity of the Yellow-heads' territories (Fig. 1). Two of their nests were located in bulrushes in a part of the marsh which was not occupied by any Yellow-heads and the others were in sedges, a type of vegetation which is much less rigid and less substantial than the bulrushes and in which no Yellow-heads established territories. Actual combat between the species during the early part of the nesting season gave evidence that the Red-wings nested in the sedges not because they chose to do so but because there were no Yellow-heads there.

Before the Yellow-heads arrived at the Provo River area, several

Marsh Wrens, *Telmatodytes palustris plesius* (Oberholser) were observed among the tamarix but shortly after Yellow-heads came, the wrens disappeared and were neither seen nor heard again until after the Yellow-heads had practically all vacated the area. Even at this late date the wrens nested and two nests were found which contained newly hatched young as late as July 22.

American Coots, *Fulica a. americana* Gmelin nested in both areas. Ten nests were located in the Provo River area, and there were probably many more, and six in the Lakeview area. The nests of the coots were often within a few feet of the Yellow-heads' nests and yet there was no evident contention between these two species, the reason probably being that they occupied two entirely different strata in the same biotic community, one nesting on the water and the other in the vegetation above the water, whereas the Yellow-heads and Redwings are members of the same stratum and thus come more directly into competition with each other.

Western Yellow-throats, *Geothlypis trichas occidentalis* Brewster nested in both areas but no nests were found within the confines of Yellow-head territories although they were suspected of having nested within some territories.

The Nevada Cowbird, *Molothrus ater artemisiae* Grinnell was observed in the vicinity of both Yellow-head colonies but no Yellow-head nests were found parasitized by it. One Western Yellow-throat nest was found which contained two cowbird eggs.

A pair of Marsh Hawks, *Circus hudsonius* (Linnaeus) nested in the marsh of the Lakeview area. Their nest was located in a part of the marsh where the bulrushes were very thick and which seemed to be the type of habitat preferred by the Yellow-heads but within fifteen or twenty meters of which the Yellow-head did not nest, undoubtedly because of the presence of the hawks (Fig. 1). The hawks were already incubating at the time the Yellow-heads arrived and although they gave no evidence of molesting the Yellow-heads yet the blackbirds would become very much excited whenever the hawks were flushed from their nest and would fly over the colony. This reaction toward the Marsh Hawks was also exhibited by the Yellow-heads when hawks of other kinds flew over the colony and also when the colonies were visited by Black-crowned Night Herons, *Nycticorax nycticorax hoactli* (Gmelin).

Four White-faced Glosy Ibises, *Plegadis guarauna* (Linnaeus) came to the Lakeview area June 10 where they built two roosting

platforms on the north and east sides of the marsh outside any territories of the Yellow-heads. They chose that part of the marsh which had been occupied by the Marsh Hawks but was now abandoned by them. The presence of the Ibises seemed in no way to disturb the Yellow-heads.

DISCUSSION

Since Howard (1907-1914) first published his work concerning territory in the life of birds as exhibited by some of the British warblers, many investigators have been interested in this phenomenon in the life histories of many species with the result that the term "territory" has come to be very loosely and indiscriminately used. Nice (1933) points out that if the concept of "territory" is to be significant this term must be used with a definite meaning. Although each investigator may not have precisely the same concept of territory yet it would be very helpful if he would clearly define his concept of the term as applied in his description and interpretation of the territorial relations of the species under discussion.

The investigations which have been made indicate that there are many types of territories in bird life and that methods of establishment and maintenance of these territories may vary with the species of bird studied. Mayr (1935) has made an attempt to classify bird territories on the basis of the purpose of the occupied space. Under this classification, he lists four types, only one of which is designated as a "true territory." This type of territory serves as a "Mating station and feeding ground for the young (Buntings, some warblers)." (Mayr 1935, p. 33). Nice (1933, p. 90) says, "Territory cannot mean just the nest spot when the adults feed in common; this may be 'nest territory,' but is a very different matter from a territory in its strict sense to which the parents confine themselves during the breeding season. Again, the very essence of territory lies in its exclusiveness; if a bird's range is not defended, it is not a true territory." According to these concepts only those birds which defend an area large enough to insure the parents and offspring an adequate food supply could be considered as having "true territories." Other investigators have spoken of certain birds as having true territories although they temporarily desert the area in which the nest is located going to other areas to feed yet which they tenaciously defend when present. Mayr lists the Buntings as having true territories yet Howard (1920, p. 125) in his description of their territorial behavior says, "Buntings desert their territories temporarily and collect in flocks on

the newly sown fields of grain." He also says, (1920, p. 255) that, "Early in the season it establishes a territory, and because food is then scarce it is forced to seek it elsewhere than on the small plot of ground which it has acquired; and so makes its way to some spot where the supply is abundant, and there, meeting with other species bent on a similar errand forms with them a flock. Part time is spent in the territory and part on the feeding ground, and between these two points a highway is formed by the bird passing constantly to and fro." In comparing the territories of the Guillemot, which requires but a few square feet of cliff, with the Peregrine which may exercise dominion over several square miles of barren moor, Howard (1920, p. 298) says, "One species must occupy sufficient ground to enable it to secure food for its young; another requires sufficient, but no more, upon which to deposit its eggs . . . ."

The writer's concept of territory as described by various investigators and as exhibited in the life history of the Yellow-headed Blackbird is as follows: To have a true territory the male bird must isolate itself; must make itself conspicuous, by song, display or both; must be intolerant of males of its own species and other species whose nesting habits are enough alike to induce competition for nesting sites and other nesting necessities; and must defend a definite area whose boundaries can be ascertained by observing the behavior of the bird. This defended area may or may not be large enough to provide an adequate food supply for the parents and offspring but it should be a place of mating and afford protection against interferences during the nesting cycle from invaders of the same species or different species whose nesting habits may be enough alike to result in competition.

Bernard Altum (1868) was first to advance the theory that the primary purpose of territory in the lives of birds is to separate them sufficiently during the nesting season so that an adequate food supply will be insured for both the parents and offspring. He even went so far as to say that the size of territory depended on the relative abundance of food. Later Howard (1920 and 1935) pointed out that the availability of food close to the nest rather than the total quantity or relative abundance within the territory, which would result in the accommodation of a maximum number of pairs, is of greatest significance. The Lacks (1933 and 1936) contend that a "food territory" is not indispensable in bird life and give evidence that it is as yet unproven that this is the significant thing in many typically territorial species. Tucker (1935) intimates that food may not have the same

significance in all territorial species but considers that the abundance of food is the most plausible working hypothesis to account for the size of territories in those species whose territory includes much more than the immediate mating and nesting area, thus intimating that a defended mating and nesting area is a territory. Lack (1935) considers that the large territories of the polygamous Bishop-bird are not correlated with food. Harrison and Buchan (1934) show that the St. Kilda Wren obtains food from only a small fraction of its territory. Venables and Lack (1936, p. 69) found that in the Great Crested Grebe, "The territory does not usually include the feeding ground of the pair, and is in all cases deserted when the young hatch," and "The territory seems to be an individual affair, of no fundamental significance to the species." Thus many of the more recent investigators have found that food is not as significant in the lives of territorial birds as was once supposed and have come to assign mating (Mayr, 1935); the insurance of non-interference during the nesting cycle (Nice, 1933); and success in reproduction (Nethersole-Thompson, 1934) as equally or more important purposes of territory.

CONCLUSIONS

Although there is a definite need for further investigation into the territorial relations of the Yellow-headed Blackbird the following tentative conclusions have been drawn from the data thus far obtained:

1. The Yellow-headed Blackbird nests in colonies in which each male establishes and maintains a definite territory.

2. The males are polygamous and from 1-5 females may nest in the same territory.

3. The male establishes his territory only in vegetation which is growing in water although he seems to exercise little choice in kinds of vegetation.

4. The females exercise dominion over a small area immediately surrounding their nests but give no evidence of recognizing the boundaries of the males' territories and do not help the males in defending their territories.

5. The males arrive before the females in the spring and may have their territories established by the time the females make their appearance.

6. Most of the food is obtained outside the nesting area.

7. The purpose of territory in this species seems to be:
   a. To insure adequate nesting sites.
   b. To aid the females in obtaining mates.
   c. To afford protection from various interferences during nesting season.

ACKNOWLEDGMENTS

The writer wishes to thank Professor C. Lynn Hayward of the Brigham Young University under whom this study was begun for his suggestions and ever-willing helpfulness; the writer's brother, "Bobby" Fautin for helping to record data in the field and in helping to measure the areas studied; and Dr. S. Charles Kendeigh of the University of Illinois for his helpful criticism and suggestions concerning the preparation of this paper.

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Fig. 1 Map of Lakeview nesting area

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The Mexican Bean Beetle Taken at Provo, Utah

Specimens of the Mexican Bean Beetle, *Epilachna corrupta* Muls., were collected on the Brigham Young University campus, by a student of entomology, Mr. George Cannon, in October, 1939. This extends the distribution of this species in Utah since it was last reported by this writer in the Pan-Pacific Entomologist, Vol. V, pp. 183-86, 1929.—V. M. T.

European Journals and the War

The non-receipt by a subscriber of any European chemical or other scientific journal seriously needed as research material should be promptly reported to the American Documentation Institute.

The Cultural Relations Committee of ADI, which cooperates closely with the Cultural Relations Division of the Department of State, is working on this problem, and hopes to be able to surmount such war obstacles as interrupted transportation, embargoes and censorship, which so grievously affected the progress of research during the last year.

The principal should be established, if possible, that the materials of research having no relation to war shall continue to pass freely, regardless of the countries of origin or destination.

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NOTES ON THE DISTRIBUTION OF NIGHTHAWKS IN UTAH [1]

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A study of a small collection of nighthawks kindly determined for Brigham Young University by Dr. H. C. Oberholser seems to warrant a few comments upon the distribution of the subspecies of *Chordeiles minor* in Utah.

For reasons to be indicated in the following paragraphs it is evident that considerable collecting and field observation must still be done before breeding ranges and migratory courses of the several subspecies are thoroughly understood. Far from offering a solution to these problems, it is the purpose in this paper to record certain information that will, it is hoped, shed some light upon the situation, and at the same time call attention to the need of further published records based upon collections of both birds and nesting data.

1. Chordeiles minor howelli Oberholser. Howell's Nighthawk

Published Records: *Chordeiles popetue* var. *henryi* Allen, 1872, p. 179 (Kansas to Utah); Henshaw, 1874, p. 8 (Mts. of Utah, breeding up to 7,000 feet.); Ridgway, 1877, p. 568 (Parley's Park and Uintah Mountains, Utah).

Chordeiles virginianus howelli Oberholser, 1914, p. 64 (Parley's Park, Wasatch Mountains (June 21, 1869, July 24, Aug. 13 and 16, 1869).

Chordeiles minor howelli (in part), Tanner and Hayward, 1934 p. 226 (La Sal Mountains, Grand and San Juan Cos., July, 1934; La Sal, San Juan Co., June, 1927, breeding).

Brigham Young University Records: One adult female; La Sal, San Juan Co., June 16, 1927; taken from nest containing two eggs (C. Cottam). One adult female; Warner Ranger Station, La Sal Mts., Grand Co., el. 9,400 ft., July 5, 1934 (C. L. Hayward). One adult male, Geyser Pass, La Sal Mts., San Juan Co., el. 10,600 ft., July 27, 1934 (D. E. Beck).

(1) Contribution No. 78 from the Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

2. Chordeiles minor sennetti Coues. Sennett's Nighthawk

Published Records: As far as the writer knows there is no previous published record for Utah.

Brigham Young University Record: One female, east shore Utah Lake, near Provo, Utah Co., August 29, 1931 (C. L. Hayward).

3. Chordeiles minor henryi Cassin. Western Nighthawk

Published Records: *Chordeiles minor henryi* Presnall, 1935, p. 202 (Region surrounding Zion National Park, Washington Co.).

Brigham Young University Records: One adult, 10-mile spring, south of Escalante, Garfield Co., June 22, 1936 (D. E. Beck); one adult female and two immature young unable to fly, Jensen, Uintah Co., July 23, 1937 (J. W. Bee and C. L. Hayward); one adult male and one female, Warner Ranger Station, Grand Co., July 14, 1934 (H. Hutchings).

4. Chordeiles minor hesperis Grinnell. Pacific Nighthawk

Published Records: *Chordeiles popetue* Baird, Allen, 1872, p. 179 (Ogden, Utah).

Chordeiles popetue henryi Ridgway, 1875, p. 30 (Salt Lake Valley, Utah).

Chordeiles virginianus hesperis Grinnell, Oberholser, 1914, pp. 49 and 51 (2 specimens, Buckskin Valley, Iron Co., Sept. 1, 1908, collected by W. H. Osgood; two specimens, Fairfield, Utah Co., June 21 and 27, 1890, collected by V. Bailey).

Chordeiles minor hesperis Stanford, 1938, p. 138 (several specimens Logan, Cache Co., September 19, 1930; Logan Canyon, Cache Co., July 29, 1937; Promontory, Boxelder Co., July 22, 1931.

Brigham Young University Records: One adult, Tremonton, Boxelder Co., June 27, 1931 (C. L. Hayward); one adult female, east side of Bear Lake, Rich Co., June 27, 1926 (C. Cottam); one adult male, Geyser Pass, La Sal Mts., San Juan Co., July 27, 1934 (D. E. Beck); one adult male, St. George, Washington Co., Sept. 11, 1933 (F. Atkin); one adult male, Ute Mountain, near state boundary, San Juan Co., Utah and Montezuma Co., Colorado, taken from a nest containing two eggs, June 23, 1927 (V. M. Tanner).

DISCUSSION

The nesting records of *C. m. howelli* from the Wasatch Mountains and from La Sal tend to substantiate the breeding range as indicated on Oberholser's map (1914, pl. III). However, the breeding ranges of *C. m. hesperis* and *C. m. henryi* appear to deserve considerable extension within the state.

It seems plausible to the writer that ~~*C. m. hesperis* and~~ *C. m. henryi* must extend its breeding range northward along the drainage of the Colorado and Green Rivers for a much greater distance than has been previously known. This view is substantiated by the fact that specimens were taken in San Juan, Grand, and Garfield Counties during the breeding season, and that a female with young still in the nest was collected at Jensen, Uintah County. The spread of this subspecies across the southern part of the state is indicated by Pressnall's report of its occurrence at Zion Canyon, Washington County (1935, p. 202).

The nesting record of *C. m. hesperis* on Ute Mountain near the Utah-Colorado state line and close to the southern extremity of the boundary would seem to extend the breeding range of this subspecies for a considerable distance eastward. Its breding range in Utah was previously (Oberholser, 1914, pl. III) designated as the northwestern part of the state. The collection of this subspecies in the La Sal Mountains, eastern Utah, July 27, 1934, further substantiates its breeding in the southeastern part of the state, although the specimen taken there may have been an early migrant.

It is of interest to note that during the course of field work in the La Sal Mountains during the summer of 1934 nighthawks appeared regularly in the late evenings feeding about the clearings and forests at elevations of 9,000 to 10,600 feet. Six specimens taken from these indivduals included all three subspecies as follows: *C. m. howelli* 3, *C. m. henryi* 2, *C. m. hesperis* 1. This information, together with the nesting data already referred to, seems to indicate an overlapping of the breeding ranges of the three subspecies in southeastern Utah. Continued and intensive collecting of breeding birds, particularly in the southeastern part of the state is greatly needed to throw more light upon the exact ecological niches of these birds that apparently breed in the same geographical area.

The specimen of *C. m. sennetti* collected at Utah Lake was undoubtedly a migrant individual. This bird in company with a number of other nighthawks was found sitting on the bare sand a few rods

from the water. Whether or not the other individuals were of the same subspecies cannot be determined since no other collections were made. The question of the regularity of the migration of *sennetti* through Utah can be answered only through future collection.

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A BIOTIC STUDY OF THE KAIPAROWITS REGION OF UTAH (1)

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Brigham Young University

INTRODUCTION

The Kaiparowits region because of its aridity, ruggedness, and inaccessibility has remained practically unknown biologically. Located between parallels 37° and 38° and meridians 110° 45′ and 112° 30′, it is bounded on the southeast by the Colorado River, on the south by the Arizona State line and the west by the Paria River—Bryce Canyon area, while to the north is the Aquarius Plateau and on the northeast Halls Creek and the Henry Mountains. This region as designated by Gregory and Moore (2) has an area of about 5,400 square miles. A bird's-eye view of the area, looking north from the Utah-Arizona state line, is shown in Figure 1. Not all the region shown in this figure has been traversed by members of the surveying parties. Instead we have confined our efforts, in the main, to studying the Escalante River drainage.

In this the first of a series of reports on the region, we propose to briefly outline the purpose and extent of the investigation to date, and then discuss the biotic formations and certain animal groups.

This work was begun on June 8, 1936, when the writer, D. E. Beck, James Bee and C. L. Hayward spent 810 man hours in various parts of the Escalante River drainage. In September 1937, C. L. Hayward and the writer spent 180 man hours in the Paria valley. The

(1) Contribution No. 83—Dept. of Zoology and Entomology, Brigham Young University.

(2) Gregory, H. E. and Moore, R. C., The Kaiparowits Region. A Geographic and Geologic Reconnaissance of Parts of Utah and Arizona: U. S. Geol. Survey Prof. Paper 164, 1931.

Figure 1. The Kaiparowits region looking north from the Utah-Arizona state line. From Table Cliff pass to the Navajo Mountains, air-line distance, it is approximately 90 miles, to the Henry Mountains from Navajo Mountains it is 40 miles and from the Henry Mountains to Table Cliff Pass is about 65 miles. (From Gregory — Zion-Bryce Museum Bull. No. 4, 1940, through the courtesy of Mr. H. V. Walker, Naturalist, Zion National Park.)

work was carried on in 1938-39-40 by Dr. Beck who spent 760 man hours in 1938 with a party of three besides himself, consisting of James Bee, Wilmer W. Tanner and George Cannon. (Fig. 2). In 1939, Dr. Beck, Harry Chandler, Tom Peterson, Josiah Barker and Jesse Spencer, the latter two men from Escalante acting as pack horse guides, spent 590 man hours. They worked mainly during the month of August, exploring the course of the Escalante River from the mouth of Calf Creek to the Colorado River, then south four miles to the

Figure 2. Members of the 1938 party. Left to right—D. E. Beck, George Cannon, Wilmer Tanner and James Bee. (By permission of Utah Magazine.)

"hole in the rock," famous crossing of the Colorado made by Mormon Pioneers in the winter of 1879-80. Dr. Beck placed a bronze pioneer marker on a prominent ledge over which the intrepid colonizers struggled to get their 80 wagons, 1200 head of live stock, 200 men and women, and 50 children down and across the river. This pioneer undertaking ranks as one of the most notable and daring adventures, engaged in by the Mormon colonizers, in southern Utah.

In 1940, Dr. Beck and Irvin McArthur spent 70 man hours during the last of May and the early part of June collecting and photographing the area east of the Willow Spring Tank down to the Escalante River.

TOPOGRAPHY

This area was chosen for faunistic study because it is a part of the Colorado Plateau province in south central Utah which until recently

has been practically inaccessible. The topographic features are plateaus, mesas, isolated cliffs and buttes and deeply intrenched canyons in sedimentary rocks, mainly Mesozoic in age. The present topography is due to water and wind erosion combined with folding and faulting. As one looks out over this great expanse from the auto highway on Table Cliff pass a thrilling panorama of the results of the action of erosion is beheld. From this point to the southeast across Glen Canyon, at the end of the Kaiparowits Plateau, 90 miles distant, may be seen Navajo Mountains (Fig. 1). A little northeast and at a distance of 65 miles the Henry Mountains stand out conspicuously. Most of the area within this triangle is the Escalante River drainage area of approximately 1,900 square miles. The Aquarius Plateau to the north, in which the Escalante River and many of its tributaries originate, has an elevation of 10,000 to 11,600 feet. From this lava capped, forest covered plateau, the country slopes to the south; Glen Canyon at the junction of the Escalante River being only 3,305 feet in elevation. All this area is very well drained, small as well as deep gullies and washes are almost endless. As a result of this the scant precipitation is soon conveyed to the Colorado River. Travel over much of this region is practically impossible without a guide and pack horses.

CLIMATE

From the records on precipitation kept at a numbers of towns in the Kaiparowits region it is evident that the rainfall is insufficient for the production of crops without the aid of irrigation. The annual mean rainfall at Escalante, elevation 5,700 feet, for the years 1901 to 1927, was 12.14 inches and for Cannonville during the years 1890 to 1918 it was 11.37 inches. Along the Colorado River from Halls Creek to Lees Ferry the mean annual rainfall varies from 5 to 8 inches. During the months of July, August and September from one third to one half of the annual rainfall is precipitated as thunder showers, ofttimes causing floods and being of little benefit to the county because of the rapid runoff and evaporation.

The annual, as well as daily, temperature variation is very great, definitely affecting the plant and animal life of the region. Throughout this entire region subzero temperatures may be experienced during the winter. At Cannonville, altitude 6,000 feet, a record of 32° below zero was recorded for the month of February. During the summer months high temperatures up to 120° are fairly common. Then, too, the daily changes are considerable. On June 21, 1936 at Willow Spring Tank, in the Escalante Desert, the atmospheric tem-

perature reached 108° while the surface soil reached 134°. On the following morning, June 22 at 4:40 A. M. the atmospheric temperature was 49°, a difference in less than twelve hours of 59°, and this in spite of clear cloudless skies. The zoologist soon learns that he must collect in the evening and early mornings in this desert country. After sundown the hiding species of the desert begin their foraging and one is soon made aware of the statement that the "night has a thousand eyes."

PREVIOUS WORKERS

Finally because of the nature of the country, desert conditions, with extremes in temperatures, and the paucity of biological information we decided to collect and study the fauna and flora of this region. While considerable has been written about the geology of the area by Powell (3), Dutton (4), Gilbert (5), and Gregory and Moore (6), very little has been published on the biota. In 1922 Drs. Moore and Hungerford (7) reported upon the water insects collected in this region. They listed eight species which were collected by Dr. Moore while engaged in his studies on the geology of this region.

The reptiles and amphibians of Bryce Canyon National Park were discussed by Tanner (8) in 1930, and this same year Chamberlin and Berry (9) listed the Mollusca they had collected in the Henry Mountains.

Miss Helen Dixon (10) spent considerable time during several summers studying the plant associations of the southern High Plateaus of Utah. Most of her study was carried on in Wayne County to the north of the area under consideration. In May, 1931, Mr. W. D. Stanton (11) completed a master's thesis for the Botany Department

(3) Powell, J. W., Exploration of the Colorado River of the West and its tributaries. Smithsonian Institution, 1875.

(4) Dutton, C. E., Report on the Geology of the High Plateaus of Utah. U. S. Geog. and Geol., Survey Rocky Mts. Region, 1880.

(5) Gilbert, G. R., Report on the Geology of the Henry Mountains, 2nd Edition, 1880.

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(11) Stanton, W. D., A preliminary study of the Flora of the Henry Mountains of Utah. A masters Thesis; unpublished, Brigham Young University, May, 1931.

at Brigham Young University, in which he discussed the plant associations or formations of the Henry Mountains. Mr. Stanton recognized six formations and expressed the belief that 60 per cent of the flora of the mountains had a northern origin.

Dr. Gregory (12) briefly discusses the plants of the area recognizing three plant zones. He also included a short list of forest plants which was furnished by Wallace M. Riddle, forest supervisor.

These are the only studies that have come to our attention in which the plants and animals have been discussed. It is obvious from this that very little is known about the fauna of this portion of Utah. While much remains to be done in completing the ecological studies and making the desired interpretations of the data collected, it is our belief that the following discussion of the plant and animal associations and the animals listed should be published at this time. The writer desires to thank Mr. H. V. Walker, Park Naturalist of Zion National Park for the permission to use Figures 1 and 10; Dr. D. Eldon Beck and Mr. Harry Miller of the Utah Magazine for the use of Figures 2, 3, 4 and 11; Dr. B. F. Harrison and Mrs. Desma Hall Galway for aid in determination of the plants collected, and the various members of the collecting parties. The thrill, however, of exploring and collecting in this virgin, unstudied region is its own reward.

BIOTIC COMMUNITIES

In making a study of this kind it is of first importance that the species of the area be collected, listed and their abundance and distribution determined. With information of this kind at hand it is possible, with knowledge of the topography, climate and fauna, to make an interpretation and classification of the communities.

DESERT-PRAIRIE COMMUNITY

The entire Kaiparowits region belongs to the North American Grassland biome and much of it to the mixed Prairie association, if we follow recent workers in Bio-ecology (13). The Escalante Desert, altitude 4,250 to 5,200 feet, extending south along the straight cliffs and east along the Escalante River to Glen Canyon, contains many of the dominants, sub-dominants and influents of the mixed Prairie association. This area is, however, along an ecotone since there is a noticeable merging of the mixed prairie with the non-grasslands; also

(12) Idem, p. 24.
(13) Clements, F. E. and Shelford, V. E., Bio-Ecology, 1939.

many of the buffer species betwen the Lower and Upper Sonoran zones, are encountered. Because of the mixing of the desert and prairie species in what appears to be a rather wide ecotone I prefer to call this the Desert-Prairie community to the Mixed Prairie association now in common usage. This desert may be divided into a number of seral stages. The shifting sands, steep walls of the washes and canyons, and water holes provide many dynamic seral groupings (Figs. 3, 4, 5, 6, 7, and 8). Disregarding these seres at present, but listing

Figure 3. Death Hollow from the Skyline Bridge on the road between Boulder and Escalante. Practically no life is able to maintain itself upon the steep walls. (By permission of Utah Magazine.)

the dominants and influents we find the following species, all of which were collected 50 miles southeast of Escalante at Willow Spring Tank and Hall Cave, water holes on the desert, between the straight cliffs and the Escalante River and about 20 miles northwest of Glen Canyon:

PLANTS

Ephedra torreyana; Hilaria jamesii; Aristida glauca; A. longiseta; Stipa comata intermedia; Oryzopsis hymenoides; Sporobolus flexuosus; Polypogon monspeliensis; Agrostis sp.; Poa fendleriana; Bromus tectorum; Eleocharis montana; Yucca harrimaniae; Quercus undulata; Q. turbinella; Q. pungens; Eriogonum inflatum; E. shockleyi; E. nummulare; Eriogonum sp.; Polygonum aviculare; Cycloloma atriplicifolium; Chenopodium album; Salsola pestifer; Amaranthus blitoides; Tripterocalyx pedunculatus; Tripterocalyx cyclopterus; Abronia alliptica; Clematis ligusticifolia; Stanleya sp.; Lepidium sp.; Cleome lutea; Coleogyne ramosissima; Cowania stansburiana; Krameria glandulosa; Astragalus americanus; Linum aristatum; Chamaesyce parryi; C. fendleri; Rhus utahensis; R. trilobata; Sphaeralcea coccinea; Opuntia rhodantha?; Mentzelia multiflora; Lepargyrea rotundifolia; L. argentea; Pachylophus marginatus; Asclepias cryptoceras; Gilia gunnisonii; Euploca convolvulacea; Cryptanthe crassisepala; Solanum triflorum; Pentstemon ambiguus; Coleosanthus oblongifolius linifolius; Chrysothamnus nauseosus; C. filifolius; Erigeron bellidiastrum; Franseria acanthicarpa; Xanthium pensylvanicum; Wyethia scabra; Helianthus anomalus; Laphamia palmeria; Hymenopappus eriopodus; Artemisia filifolia; A. mexicana; A. cana; and Ptiloria pauciflora.

MAMMALS

The following represent only the species collected in traps or observed; a number of species were reported by some of the old settlers to have been in that region when it was first occupied:

Perognathus l. arizonensis; Dipodomys o. cupidineus; Peromyscus maniculatus sonoriensis; Lepus c. deserticola; Citellus l. cinnamomeus; Lasionycteris noctivagans; Pipistrellus hesperus hesperus; Thomomys b. absonus; and *Canis estor.*

The pronghorn antelope, *Antilocapra americana,* was common in this area in pioneer days, 1875, extending northward along the Colorado River to the San Rafael Swell, the Green River and the Uinta Basin. Today there are remnant herds in Emery County around the San Rafael and Green River, south of the Uinta Basin.

BIRDS

Only the common species that are met with daily are listed:

Mimus polyglottos leucopterus (A young specimen was collected June 21, by D. E. Beck (14); *Chordeiles minor henryi; Cyanocephalus*

(14) Tanner, Vasco M., The Western Mocking Bird in Utah, Proc. Ut. Acad. of Sci., Vol. 13, pp. 185-87, 1936.

cyanocephalus; Euphagus cyanocephalus; Sayornis saya saya; Zenaidura macroura marginella; Lanius ludovicianus excubitorides; Bubo virginianus pallascens; Sialia currucoides.

INSECTS

In addition to the aquatic insects reported elsewhere in this study the following characteristic species are listed:

Hesperotettix viridis; Heliastus aridus; Trimerotropis vinculata; Cacama valvata; Enpagoderes sordidus; Eleodes obsoleta var. porcata; E. extricata var. cognata; E. hispilabris; Erax barbatus; and *E. argyrosoma.*

The grazing of sheep, horses and cattle in the Kaiparowits region has made changes in the plant cover and the native fauna. Thousands

Figure 4. Natural Bridge, near the mouth of Calf Creek. (By permission of Utah Magazine.)

Figure 5. *Colcogyne-Krameria* associes at Willow Spring Tank looking southeast showing the straight cliffs with Navajo Mountain at the end. The light areas (A) are mainly *Krameria* while the dark areas (B) are mainly *Colcogyne*. Photo by D. E. Beck, 1940.)

Figure 6. The Hall, showing the manner in which the Entrada Sandstone (Jurassic) weathers. The plant cover is mainly Blackbrush, *Colcogyne ramosissima*. (Photo by D. E. Beck, 1938.)

of acres of sandy desert around the Hall and Willow Spring Tank, (Figs. 5 & 6), at present, have a plant cover, estimated through counting various plots, which is composed of Blackbrush, *Coleogyne ramosissima*, 75 per cent; Krameria, *Krameria glandulosa*, 10 per cent;

Figure 7. The Chimney Rock or Sentinel, near Willow Spring Tank. The sand dune in the right corner is being held by *Ephedra torreyana*. The light colored plants are *Kramaria* and the dark colored ones in the background are *Coleogyne*. The Pocket Mouse, *Perognathus l. arizonensis*, and Kangaroo Rat, *Dipodmys o. cupidinus* burrow into the sand dunes. (Photo by D. E. Beck, 1940.)

Figure 8. Desert near Coyote Gulch. Showing the grass *Aristida longiseta* (B) in association with *Coleogyne* (A) and *Ephedra torreyana* (C). (Photo by D. E. Beck.)

Matchweed, *Gutierrezia* spp., 5 per cent; Brigham tea, *Ephedra torreyana*, 2 per cent and Prickley pear, *Opuntia rhodantha*, 2 per cent. It was also noted that there is considerable variation between *Coleogyne* and *Krameria*, with respect to their dominants. In Figure 5 the light areas are 70 to 80 per cent *Krameria* while in the dark areas are 70 to 80 per cent *Coleogyne*. This may be due to a number of factors such as, soil and water, either one or both. In Figure 7 in the right hand side *Ephedra* is shown serving as a sand binder, while the plant in the light foreground is mainly *Krameria* and the dark plant extending back to the chimney rock is *Coleogyne*.

Figure 9. Pinyons and Junipers at Escalante, Utah. The Escalante River in the background is lined with cottonwoods, *Populus fremontii*. (Photo by D. E. Beck, 1940.)

Between Collett Wash and Coyote Gulch are areas in which the grasses, *Aristida glauca* and *A. longiseta* are common (Figure 8). These grasses are not so palatable to live stock, as other species, which may account for their abundance at present.

PINYON-JUNIPER ASSOCIATION

Surrounding the Escalante desert on the foothills of the Aquarius Plateau, Circle Cliffs, Straight Cliff, Table Cliff, Potato Valley, and Paria Valley is a Pinyon-Juniper association in the Woodland, Pinyon-Juniper formation at an altitude of 5,500 to 7,000 feet (Fig. 9).

Some of the dominants of this association are:

PLANTS

Pinus edulis; Juniperus utahensis; Phragmites communis; Puccinellia nuttalliana; Tradescantia scopulorum; Juncus balticus; Juncus longistylis; Quercus wilcoxii; Comandra pallida; Rumex crispus; Atriplex confertifolia; Cercocarpus intricatus; Amelanchier spp.; Sphaeralcea marginata; S. munroano; Tamarix gallica; Fraxinus anomala; Frasera speciosa; Apocynum cannabinum; Asclepias tuberosa; Gilia subnuda; Cryptanthe fendleri; Verbena bracteosa; Castilleja exilis; Grindelia squarrosa; Petradoria pumila; Chrysothamnus graveolens; Aster hirtifolius; Chaenactis douglasii; Artemisia forwoodii; A. ludoviciana; A. carruthii; Ptiloria exigua.

MAMMALS

The following are common influent species found ranging in, as well as above and below, this belt:

Neotoma l. monstrabilis; Eutamias adsitus; Citellus l. lateralis; C. v. utah (15); *C. l. cinnamomeus; Peromyscus sp.; Taxidea taxus berlandieri; Cynomys parvidens;* and *Sylvilagus a. warreni.*

BIRDS

Most of the following birds were collected in the environs of Henrieville:

Polioptila c. amoenissima; Vireo gilvus swainsoni; Agelaius sp.; Hedymeles m. papago; Guiraca c. interfusa; Passerina amoena; Passerculus s. nevadensis; Pipilo maculatus montanus; Pooecetes g. confinis; Chondestes grammacus strigatus; Spizella passerina arizonae; S. breweri breweri; Zonotrichia l. gambelii; Acronautes s. saxatalis; Petrochelidon a. albifrons; Aphelocoma c. woodhousii; Cinclus mexicanus unicolor; Bacolophus i. griseus; Troglodytes aedon parkmanii.

The insects in this association were so generally distributed in the associations above and below that no list is reported.

The Pinyons and Junipers cover in the main the mesas and foot

(15) From a study of the skins available of the two subspecies *C. v. grammurus* and *C. v. utah* taken in various parts of southern Utah and with the aid of A. H. Howell's North American Fauna No. 56, 1938, we have not been able to make a satisfactory determination of the ranges of these subspecies in Utah; however, the following represents our present decision in the matter. Specimens from St. George (1), Washington County; La Sal Mts. (2), San Juan County; and Woodside (2), Emery County, are *C. v. grammurus;* while skins from Aspen Grove (1), Vivian Park (1), Grove Creek Mount Timpanogos (1), Provo (2), Utah County; Mount Nebo (1), Juab County; Aurora (1), Sevier County; Beaver (2), Beaver County; Cedar City (1), Iron County; Henrieville (1), Moki Tanks (1), Circle Cliffs, in Garfield County; and Fruita (1), Wayne County, agree with the descriptions given for *C. v. utah.*

Figure 10. Table Cliff Mountain in the distance looking across Paria River Valley and Bryce Canyon from Inspiration Point. The town of Tropic, Utah, to the right, is in upper Paria Valley. (N. P. S. photo by Grant. From Gregory, Zion-Bryce Museum Bull. No. 4, 1940, through the courtesy of Mr. H. V. Walker, Naturalist, Zion National Park.)

hills; in some places almost pure stands of these dominants are found interspersed with scattered sage brush, *Artemisia tridentata*, and Mountain Mahogany, *Cercocarpus intricatus*. (Fig. 10).

YELLOW PINE-OAK-MANZANITA COMMUNITY

Extending in a northeasterly direction from the south end of Table Cliff Mountain (Fig. 10) beyond Birch Creek, Pine Creek, Boulder Creek to Steep Creek at an elevation of 7,000 to 8,500 feet is a belt of Yellow Pine interspersed with Oak brush and Manzanita.

This is a distinctive community, appearing as an ecotone between the Desert Scrub Climax below the Montane Forest Climax above. Here the Manzanita, then the Oak, and Yellow Pine are associated in separating the Pinyon-Juniper from the Aspen-Balsam-Spruce forest. The dominants and influents of this assemblage mix or dove-tail into the contact associations to a very noticeable extent.

The following are some of the common plants:

PLANTS

Pinus brachyptera; Juniperus scopulorum; Agropyron sp; Fritillaria atropurpurea; Salix pseudomyrisinites; Betula fontinalis; Quercus utahensis; Monolepis nuttalliana; Arenaria aculeata; Thalictrum sp.; Cheirinia elata; Ribes cereum; Potentilla concinna; Geum macrophyllum; Rosa sp.; Prunus melanocarpa; Vicia trifida; Linum lewisii; Artostaphylos platyphylla; Convolvulus arvensis; Erigeron compositus incertus; Antennaria microphylla; Actinea arizonicus; Achillea lanulosa alpicola; Artemisia tridentata.

MAMMALS AND BIRDS

The following mammals and birds were taken in the Oak brush of this association:

Neosorex p. navigator; Thomomys fossor; Neotoma cinerea cinerea; Cyanocitta s. cottami; Nucifitoga columbiana; Troglodytes aedon parkmanii.

THE SPRUCE-BALSAM-ASPEN ASSOCIATION

The face of the Aquarius Plateau, at elevations between 8,500 to 10,000 feet, above the Yellow Pine, Oak brush to the rim of the Plateau is rather distinctly marked off from the Coniferous-Alpine meadow cover of the plateau proper. This belt is noticeable at the Table Cliff pass, Pine Creek, Posy Lake highway and Boulder Highway on the Boulder Mountain. It extends over great areas of the plateau. At Table Cliff Plateau and Mt. Roger both about 10,000 feet are great stands of spruce, balsam and aspens surrounding open meadows.

Dominants and influents follow:

PLANTS

Pinus aristata; Pinus flexilis; Picea pungens; Pseudotsuga mucronata; Juniperus sibirica; Calamagrostis inexpansa; Catabrosa aquatica; Poa fendleriana; Glyceria striata; Festuca thurberi; Carex festivella; Vagnera stellata; V. liliacea; Corallorhiza maculata; Populus aurea; Salix bebbiana;Urtica breweri; Persicaria amphibia; Orcobroma pygmaeum; Alsine jamesiana; Cerastium berringianum; Anemone globosa; Radicula terrestris; Physaria newberri; Lesquerella kingii; Sophia sonnei; Ribes montigenum; Potentilla concinnaeformis; Dasiphora fruticosa; Rosa woodsii; Astragalus chamaeleuce; Vicia americano; Viola montanensis; Epilobium stramineum; Gayophytum ramosissimum; Hippuris vulgaris; Cogswellia sp.; Gilia aggregata; Polemonium viscosum; Phacelia heterophylla; Moldavica parviflora; Mentha sp.; Pentstemon eatoni; Pentstemon strictus; P. procerus; Mimulus guttatus; Veronica serpyllifolia; Castilleja linariaefolia; C. confusa; Sambucus caerulea; S. microbotrys; Symphoricarpos vaccinoides; Chrysopsis villosa; Erigeron flagellaris; Hymenopappus cinereus; Actinea richardsoni; Helenium hoopesii; Achillea lanulosa; Senecio spartioides; Leontodon taraxacum.

BIRDS AND MAMMALS

Ochotoma sp.; Thomomys sp.; Citellus lateralis lateralis; Microtis sp.; Myostis v. interior; Mierotus mordax; Eutamias minimus consobrinus; Eutamias adsitus; Hyclocihla guttata auduboni; Myadestes townsendii; Junco caniceps; Colaptes c. collaris; Sphyrapicus varius nuchalis; Sphyrapicus t. nataliae.

ENGELMANN SPRUCE-ALPINE MEADOW ASSOCIATION

This zone is very irregular, mixing down into the Balsam-Aspen belt below. The Aquarius Plateau with an elevation of 10,500 to 11,600 feet, is, in places, covered with extensive forest of *Picea engelmannii*. This may be contrasted with Mount Timpanogos in the Wasatch Mountains which is practically treeless, above 10,500 feet. The exposure and heat absorbing qualities of the surface cover are important factors in these cases. The Aquarius Plateau is rather flat and mesa-like which makes it possible for trees to become established, also the heat and moisture is fairly well distributed and held. The opposite to this is more or less true in the case of Mount Timpanogos which is steep and rugged without areas for plant growth. This

would seem to emphasize the point that the exposure and heat absorbing qualities of an area are more important than actual altitude in determining the biota. Dwarfed aspens extend up to 10,600 feet. The alpine meadows, xerophytic and mesophytic, due to present drainage and wind, as well as glaciation during the Pleistocene, have many herbaceous plants which bloom during the last of June and July.

PLANTS

Some of the species are as follows:

Aster glaucodes; Antennaria rosulata; Artemisia cana; Chrysopsis villosa; Helenium hoopesii; Leontodon taraxacum; L. lyratum; Senecio spartioides; S. suksdorfii; Thlaspi glaucum; Astragalus chamaeleuce; Gilia subnuda; Polemonium viscosum; Oreobroma pygmaeum; Ranunculus sceleratus; Potentilla concinnaeformis; Rosa woodsii; Pentstemon procerus; and *Veronica serpyllifolia.*

MAMMALS AND BIRDS

Species of mammals and birds that were taken are as follows:

Ochotoma spp.; Thomomys spp.; Peromyscus spp.; Tamiasciurus spp.; Dryobates thyroides nataliae; Anus p. platyrhynchas, (Found breeding at Cyclone Lake, several young ducks were collected and observed); *Spizella passerina arizonae; Junco caniceps; Dendrica a. audubonii; Sialia curricoides; Numenius a. americanus; Spinus p. pinus; Pooecetes gramineus confinis; Hesperiphona vespertina brooksi; Actitis macularia; Fulica a. americana;* and *Myochanes r. richardsoni.*

INSECTS

The greatest amount of collecting was done in the Spruce-Balsam-Aspen and the Engelmann-Alpine formations. Insects were found abundant and easy to collect. The following are some of the most characteristic species which were taken:

Okanagana bella; Orphia canora; Circatettix verruculatus; Cicindela l. montana; C. l. laurenti; Rhagium lineatum; Magdalis lecontei var. tenebrosa; Peritoxia uniformis; Crocidema nigriae; Thereva frontalis; Cryptopogon bimacula; Stenopogon rufibarbis; Crytopogon plausor; and *Laphria janus.*

LISTS OF ANIMAL SPECIES

The following list of Mollusca, Aquatic insects, Amphibians, and Reptiles represent some of the interesting animal species of this area.

It is impossible at this time, because of space, to list other groups. The collectors are reported by their initials: D. E. B., D. Eldon Beck; H. C., Harry Chandler; W. W. T., Wilmer W. Tanner; J. B., James Bee; and V. M. T., Vasco M. Tanner.

LAND SNAILS — Mollusca

Sphaeriidae

Pisidium abditum Haldeman

Localities: Specimens of this species were collected at Posy Lake, Steep Creek Lakes and in a small pond south of the Table Cliff Pass, at elevations from 8,500 to 9,500 feet. Collections were

Figure 11. Posy Lake, Aquarius Plateau, elevation 9,250 feet. A stand of aspens in the background. (By permission of Utah Magazine.)

made in June, 1936 by V. M. T. and D. E. B., and in 1939 by H. C.

Habitat: The lakes of the Aquarius Plateau are small natural ponds, varying from less than an acre to 8 or 10 acres in surface area and about 1 to 20 feet deep (Fig. 11). The following are some of the plants found in and about these ponds: *Potamogeton richardsonii; P. interior; Chara sp.; Carex aquatilus; Lemna trisulca; Salix beddiana; Urtica breweri; Alsine borealis; Aquilegia caerulea albiflora; Ranunculus sceleratus; Thalictrum megacarpum; Arabis drummondii;*

Geranium caespitosum; Viola sp.; Plemonium occidentale; Sambucus caerula; and *Veronica americana.* The fresh water sponge, *Spongilla lacustris* was collected in a number of the lakes. The following Amphibians are common in these ponds, feeding upon the aquatic insects and mollusca: *Ambystoma tigrinum; Scaphiopus intermontanus;* and *Pseudacris triseriata.* Fish have been introduced into some of the ponds such as Posy Lake, and will continue to succeed if the ponds are not overstocked, since the food grade of this lake is high.

Helicidae

Vallonia cyclophorella Ancey

Locality: Several specimens of this species were collected in August, 1939, along the Escalante River by H. C.

Oreohelix strigosa depressa (Cockerell)

Localities: This species was found to be common on Table Cliff Mountain, 20 miles west of Escalante, at an elevation of 9,300 feet. Collections were made on June 11, 1936, by V. M. T.

Habitat: Common under decaying logs of *P. flexilis,* and *P. engelmannii.* This species is also found in the leaf litter in the aspen groves, as well as in rock slides and ledges. It is common in most parts of eastern Utah.

Microphysula ingersolli (Bland)

Locality: Specimens were taken on the Aquarius Plateau above Posy Lake, June 26, 1936, by D. E. B. These were taken under logs while collecting Collembola.

Pupillidae

Vertigo coloradensis (Cockerell)

Locality: Harry Chandler collected a number of specimens at Steep Creek in August, 1939.

Zonitidae

Nirtrina alaskana Dall

Localities: This species was found to be fairly common at Steep Creek and along the Escalante River on August, 1939, by Harry Chandler.

Euconulus fulvus alaskensis (Pilsbry)

Localities: Harry Chandler collected specimens of this species at Steep Creek and Calf Creek in August, 1939.

Zonitoides arborea (Say)

Localities: This species was collected at various places along

the Escalante River to the Colorado River and at Steep Creek, in August, 1939, by H. C.

Succineidae

Succinea avara Say

Locality: This species has only been collected in the Steep Creek Lakes by V. M. T. in July, 1936 and by H. C. in August, 1939.

Endodontidae

Gonyodiscus cronkhitei (Newcomb)

Locality: A few specimens collected at Steep Creek in August, 1939, by H. C.

Lymnaeidae

Lymnaea palustris nuttalliana (Lea)

Localities: Specimens of this species collected at Posy Lake, Steep Creek, Boulder Mountain on July 1, 1936, by V. M. T. Specimens were also taken at Steep Creek on June 23, 1938, by D. E. B. and W. W. T. and Cyclone Lakes, June, 1938, by W. W. T.

Lymnaea modicella modicella (Say)

Localities: This species was found to be fairly common by V. M. T. in the streams running into and from Posy Lake, in June, 1936.

Planorbidae

Helisoma trivolvis trivolvis (Say)

Localities: Collections of this species were made at Posy Lake, and Steep Creek in June and July, 1936, by V. M. T. and D. E. B.; also in June, 1938, by W. W. T.

Gyraulus vermicularis vermicularis (Gould)

Localities: A common species in the beaver ponds near Boulder and in the lakes at Steep Creek in June and July, 1936. Collections were made by V. M. T. and D. E. B.

Physidae

Physa ampullacea (Gould)

Localities: A common species in the streams of Boulder Valley in June, 1936, and 1938. Specimens were collected by V. M. T., D. E. B. and W. W. T.

AQUATIC INSECTS

MAYFLIES — Order Ephemerida

Baetis sp.

Locality: Several specimens of this species were collected in

Birch Creek, eight miles west of Escalante on June 15, 1936, by V. M. T. The Mayflies reported here are common in the streams of the Wasatch and High Plateaus of Utah.

EPHEMERELLA INERMIS Eaton

LOCALITY: Five specimens were taken in Birch Creek, at the Green Ranger Station on June 15, 1936, by V. M. T.

RITHROGENA MIMUS Eaton

LOCALITY: Collected by V. M. T. in Birch Creek below the Green Ranger Station, June 15, 1936.

STONEFLIES — Order Plecoptera

PTERONARCELLA BADIA (Hagen)

LOCALITY: Naiads of this species were taken in Birch Creek above the Green Ranger Station, elevation 6,500 feet, June 15, 1936, by V. M. T.

CADDIS FLIES — Order Trichoptera

LIMNOPHILUS SP.

LOCALITY: Taken in a small pond above Green Ranger Station on Birch Creek, June 15, 1936, by D. E. Beck. The cases were made of Molluscan shells, *Psidium abditum*.

DRAGON FLIES AND DAMSEL FLIES — Order Odonata

LIBELLULA QUADRIMACULATA L.

LOCALITY: This species is fairly common throughout the Escalante River drainage. Specimens were taken around the small lakes at Steep Creek, Boulder Mountains in July, 1936 and June, 1938 by V. M. T. and W. W. T.; also along the seeps of Collett Creek south of Escalante, June 17 and 23, 1936, by V. M. T.

SYMPETRUM CORRUPTUM (Hagen)

LOCALITIES: This is the common dragon fly in this region. It was taken along Collett Creek, Garfield County, June 15, 1936, and Willow Tank Springs, Kane County, June 18, 1936; Escalante River near the town of Escalante, June 8, 1936 and Boulder, June 27, 1936 by V. M. T. D. Eldon Beck and Harry Chandler collected this species at Calf Creek, August, 1939.

LESTES UNCATUS Kby.

LOCALITY: Several specimens collected along Collett Creek on June 21, 1936, by V. M. T.

ENALLAGMA CYATHIGERUM (Charpentier)

LOCALITIES: Specimens taken on the Aquarius Plateaus at Mt. Rogers, Posy Lake, and Steep Creek; also at Boulder and Escalante in June, 1936, by V. M. T.

ARGIA VIVIDA Hagen

LOCALITIES: This species was abundant along the Escalante River, near the town of Escalante, on June 8, 1936. A few individuals were taken at Steep Creek on July 1, 1936, by V. M. T.

AMPHIAGRION ABBREVIATUM (Selys)

LOCALITIES: This common Utah species was collected at Escalante on Collett Creek in June, 1936, by V. M. T.

LEUCORRHINIA INTACTA (Hagen)

LOCALITY: This species has only been taken at a lake on Boulder Mountain, 9,000 feet elevation, in June, 1938, by W. W. T.

LEUCORRHINIA HUDSONICA (Selys)

LOCALITIES: This species known only from Tryol Lake in the Uintah Mountains of Utah where it was collected by the writer in July, 1930, at an altitude of 10,000 feet; was also collected at Boulder on June 28, 1936, and Notom, Wayne County, Utah, July 2, 1936, by V. M. T.

WATER BUGS — Order Hemiptera

ARCTOCORIXA ABDOMINALIS (Say)

LOCALITIES: This common species was taken in water puddles at Escalante, Collett Creek, Willow Spring Tank and Boulder, in June, 1936, by V. M. T. It was taken by D. E. B. and H. C. at Calf Creek on the Escalante River in August, 1939.

NOTONECTA INSULATA Kby.

LOCALITIES: This common Utah species was collected at Willow Spring Tank, Collett Creek, Escalante, Birch Creek, Posy Lake, Cyclone Lake, Boulder Creek and Steep Creek, in June, 1936 by V. M. T. Specimens also were taken at Calf Creek and on the Escalante River by D. E. B., H. C., and W. W. T. in 1938 and 1939.

NOTONECTA SPINOSA Hungerford

LOCALITY: Specimens were taken at Escalante, Utah, June 8, 1936, by V. M. T. This species was named by Dr. Hungerford from specimens taken at Lehi, Utah County, Utah.

LETHOCERUS AMERICANUS (Leidy)

LOCALITY: Several adult specimens were taken on the Escalante River near its Junction with the Colorado River, in August, 1939, by D. E. B. and H. C.

GELASTOCORIS OCULATUS Fab.

LOCALITIES: This species is common on the sand bars of the Escalante River, Collett and Boulder Creeks.

RHAGOVELIA EXCELLENTIS Drake and Harris

LOCALITIES: This species was fairly common on the Escalante River and Boulder Creek. A total of 83 specimens taken in 1936, by the writer and 1939 by D. E. B. and H. C. agree perfectly with the specimens of *R. excellentis* which are before me. Mr. Torre-Burno, in 1921, reported *R. distincta* Champ, from the Yampa River in N. W. Colorado which leads the writer to suspect that this record may prove to be *excellentis*. A large series of specimens of *distincta* have been studied and they are very different to any species found in this portion of the Colorado River.

GERRIS REMIGIS (Say)

LOCALITIES: Collected at Boulder and Steep Creek in June, 1936, by V. M. T.

GERRIS ORBA Stal.

LOCALITY: Several specimens were taken at Boulder in June, 1936, by V. M. T. It has been reported from Bluff, Utah.

GERRIS GILLETTEI Leth. and Sen.

LOCALITIES: A common species at Posy Lake and in Boulder Creek in June, 1936. It was collected by V. M. T.

GERRIS NOTABILIS Drake and Harris

LOCALITIES: Taken at Posy Lake, Boulder Creek and Escalante River in June, 1936, and August, 1938 and 1939, by V. M. T., D. E. B. and H. C.

METROBATES TRUX (Burno)

LOCALITIES: The specimens are on the whole a little smaller than those from San Marcus, Texas, taken by D. Eldon Beck, June 18, 1934. The Escalante River specimens are not so black but with much more grey, silvery pubescence on the dorsal portion of the thorax. The Utah specimens also lack the distinct flavous pattern found on the head and thorax of the Texas specimens. The male clasping structures are similar in the Utah and Texas specimens I have examined.

We have 93 specimens which were taken in August, 1939, by D. E. B. and H. C. at the mouth of the Escalante River, Kane County, Utah. This is a new record for Utah.

MICROVELIA SP.

LOCALITIES: On June 17, 1936 eight specimens were taken at a small seep near Hall Cave (Fig. 6) in Kane County, 55 miles south

of Escalante by V. M. T. In August, 1939 Beck and Chandler collected 24 specimens at Calf Creek on the Escalante River. We are unable to report definitely upon this species at present.

MESOVELIA SP.

LOCALITY: Beck and Chandler collected four specimens on the Escalante River near its junction with the Colorado River, in August, 1939. This may be a new species and a new state record for Utah.

BEETLES — Order Coleoptera

OMOPHRON OBLITERATUM VAR. UTENSE Csy.

LOCALITY: Harry Chandler collected a large series of this and the following species at the Mouth of Calf Creek and the Escalante River in August, 1939.

HOMOPHRON AMERICANUM VAR. TEXANUM Csy.

LOCALITY: Taken with *O. obliteratum* at Calf Creek on the Escalante River by Chandler in August, 1939. A large series of this species was taken at Moab in Grand County by the writer, in June, 1927. This is a new record for the state of Utah.

PELTODYTES CALLOSUS Lec.

LOCALITY: Several specimens collected by Harry Chandler at the Mouth of Calf Creek in August, 1939. This is a new Utah record for this species.

LECCOPHILUS DECIPIENS Lec.

LOCALITY: Several specimens taken at a water seep ten miles south of Escalante, June 16, 1936, by V. M. T. This is the first time this species has been report for Utah.

HYDROPORUS STRIATELLUS (Lec.)

LOCALITIES: Several specimens of this species were collected by D. E. Beck in June, 1940, in Coyote Gulch, five miles east of Willow Spring Tank, Kane County. Specimens of this species were collected in Several Uintah Mountain Lakes, in July and August, 1930, by the writer. This is the first time this species has been reported for Utah.

HYDROPORUS PLANIUSCULUS Fall

LOCALITIES: Five specimens were collected in the Escalante River near its junction with the Colorado River, August, 1939, by D. E. B. and H. C. This species was also taken in the Uintah Mountains in 1930, by the writer. These are new records for Utah.

AGABUS CORDATUS (Lec.)

LOCALITY: A number of specimens were taken at a seep, ten

miles south of Escalante on June 16, 1936, by V. M. T. This is a new record for Utah.

AGABUS SERIATUS (Say)

LOCALITY: Three specimens collected five miles east of Willow Spring Tank, Kane County, by D. E. B. and I. M., June, 1940.

AGABUS LUGENS (Lec.)

LOCALITIES: A number of specimens are in the collection, some from the Escalante River near its junction with the Colorado, taken in August, 1939, by D. E. B. and H. C., and others from Hanksville, Wayne County, collected by W. D. Stanton and determined by the late H. C. Fall. This is the first time this species has been reported as occurring in Utah.

AGABUS PERPLEXUS Sharp

LOCALITY: Beck and Chandler collected this species at Calf Creek, in August, 1939. This is a new record for Utah.

RHANTUS BINOTATUS (Harr.)

LOCALITY: This species was common in the lakes of the Aquarius Plateau in June, 1936 and 1938. Specimens collected by V. M. T. and W. W. T.

DYTISCUS DAURICUS Gebl.

LOCALITY: Two specimens of this interesting species taken by by W. W. T. in a small lake at Steep Creek, Boulder Mountains, in June, 1938. This species has been reported from Colorado by Wickham, but it is a new record for Utah.

THERMONECTES MARMORATUS (Hope)

LOCALITIES: Collected at Willow Spring Tank, Kane County, June, 1936, by V. M. T., and five miles east of Willow Spring Tank, June, 1940, by D. E. B. and I. M.

GYRINUS PICIPES Aube

LOCALITY: At least two species of this genus were collected on the Aquarius Plateau and the Escalante River in June, 1936, by V. M. T., but we have not been able to get one of them determined satisfactorily..

BEROSUS SP.

LOCALITY: A species of *Berosus* not yet determined was collected at Collett Creek in June, 1936, by V. M. T.

HYDROPHILUS LINEATUS Lec.

LOCALITY: This large striking species was common at Coyote Gulch in June, 1940; Beck and McArthur collected 15 specimens. A

specimen was collected at Moab, Grand County in June, 1927 by the writer. This is the first time this species has been reported for Utah.

TROPISTERNUS ELLIPTICUS (Lec.)

LOCALITY: Specimens of this species were taken at Escalante in June, 1936, by V. M. T. This is an eastern species and is a new record for Utah.

DONACIA HIRTICOLLIS Kby.

LOCALITY: Collected at Posy Lake on the Aquarius Plateau in June, 1936, by V. M. T. and June, 1940, by D. E. B.

FLIES — Order Diptera

SIMULIUM SP.

LOCALITY: Larvae of a species of Blackfly were abundant on the rocks in Birch Creek on June 15, 1936. Larvae and pupa, but no adults, were collected. The collection was made by V. M. T.

TOADS AND FROGS — Amphibians

AMBYSTOMA TIGRINUM (Green)

LOCALITIES: A common amphibian in all the lakes we studied on the Aquarius Plateau. In some ponds hundreds of individuals were found within a few square yards of water near the shore.

SCAPHIOPUS INTERMONTANUS Cope

LOCALITIES: A common species at Willow Spring Tank, Posy Lake, Steep Creek, Calf Creek and Escalante River. Specimens taken by V. M. T., W. W. T., D. E. B., J. B., and H. D., in 1936, 1938, and 1939.

BUFO BOREAS BOREAS (Baird and Girard)

LOCALITIES: Loa and Fruita, Wayne County; W. W. T. 1938.

BUFO PUNCTATUS (Baird and Girard)

LOCALITIES: Willow Spring Tank, Kane County; Junction of Boulder Creek and Escalante River, Garfield County; V. M. T. 1936, and W. W. T. 1938.

BUFO WOODHOUSII (Girard)

LOCALITIES: Fruita and Notom, Wayne County; Boulder, Steep Creek, Tropic, Escalante, and Junction of Boulder Creek and Escalante River, Garfield County.

While collecting at Calf Creek on June 28, 1938 D. E. Beck and W. W. Tanner counted, at evening, the amphibians along the creek. The following three species were collected in one hour: *Scaphiopus intermontanus* 3 adult specimens; *Bufo punctatus* 14 specimens; and

Bufo woodhousii 93 specimens. These were observed in a distance of about one-half mile. No frogs were seen.

PSEUDACRIS TRISERIATA (Wied.)

LOCALITIES: Boulder Mountain Lakes, from Steep Creek to Posy Lake, Garfield County.

HYLA ARENICOLOR Cope

LOCALITY: Three specimens were taken by D. E. B. and H. C. near the Junction of the Colorado and Escalante Rivers.

RANA PIPIENS Schreber

LOCALITIES: Orderville, Alton and the Junction of the Colorado and Escalante Rivers, Kane County; Panguitch, Garfield County. Collected by V. M. T., D. E. B. and H. C.

LIZARDS AND SNAKES — Reptiles

CROTOPHYTUS COLLARIS BAILEYI (Stejneger)

LOCALITIES: Paria, 50 miles south of Cannonville and Henrieville, Kane County. Collected by Byron Davis and V. M. T.

CROTAPHYTUS WISLIZENII Baird and Girard

LOCALITIES: Hall Cave and Willow Spring Tank, Kane County. Collected by J. B., D. E. B. and V. M. T., June 1936.

SAUROMALUS OBESUS (Baird)

LOCALITY: Collected on Warm Creek, Kane County, by Byron Davis, May 1939.

This is the first record for Utah outside of Washington County.

UTA LEVIS Stejneger

LOCALITIES: Fruita and Torrey, Wayne County; Escalante, Moki Tanks and Junction of Calf Creek and Escalante River, Garfield County; collections were made by W. W. T., D. E. B., H. C., J. B., and V. M. T.

UTA S. STANSBURIANA Baird and Girard

LOCALITIES: Fruita, Kane County; Escalante, Willow Tank, Cannonville, and Junction of Calf Creek and Escalante River, Garfield County. In 1936 J. B. and V. M. T. made collections. In 1937 and 1938 V. M. T. and W. W. T. collected this species at Cannonville.

SCELOPORUS UNDULATUS ELONGATUS (Stejneger)

LOCALITIES: Fruita and Torrey, Wayne County; Cannonville, Escalante and Junction of Calf Creek and Escalante River, Garfield County.

This is a very common species in this area. Specimens were collected by W. W. T. 1938, V. M. T. 1937, D. E. B. and H. C., 1939.

Sceloporus g. graciosus (Baird and Girard)

Localities: Fruita and Torrey, Wayne County; Moki Tanks, Lower Steep Creek, Junction of Calf Creek with Escalante River, and Tropic, Garfield County; Orderville and mouth of Escalante River, Kane County. Collectors, W. W. T. and J. B., 1938, D. E. B. and H. C., 1939.

Sceloporus magister (Hallowell)

Localities: Willow Spring Tank, Hall Cave, and Wahweap Creek, Kane County.

Specimens were collected by V. M. T. and J. B., 1936; and Byron Davis, 1938.

Phrynosoma douglassii ornatissimum (Girard)

Localities: Table Cliffs and Aquarius Plateau above Posy Lake, Garfield County; Orderville, Kane County. In 1936 specimens were collected by D. E. B., J. B. and V. M. T.

Cnemidophorus sexlineatus perplexus (Baird and Girard)

Localities: Cannonville and Escalante, Garfield County, Orderville, Kane County.

Cnemidophorus t. tessellatus (Say)

Localities: Notom and Fruita, Wayne County; Junction of Calf Creek and Escalante River, Garfield County; Hall Cave, Wahweap Creek and Mouth of Escalante River, Kane County. Specimens were collected by W. W. T., D. E. B., J. B., H. C., and V. M. T. in 1936, 1938, and 1939.

Coluber t. taeniatus (Hallowell)

Localities: Paria, Kane County; Escalante, Garfield County. Collected by W. W. T., and Walter Astel, Forest Ranger at Escalante.

Pituophis catenifer deserticola Stejneger

Localities: Fruita and Torrey, Wayne County; Tropic and Escalante, Garfield County; Orderville, Wahweap Creek and Willow Spring Tank, Kane County. Specimens were collected by C. L. Hayward, 1937, W. Astel, 1939, W. W. T., 1938.

Lampropeltis getulus boylii Girard

Locality: A large female specimen was taken by D. E. B. June 2, 1940, 30 miles south of Escalante, near the Garfield-Kane County line. The specimen measure 1320 mm in length and is identical with the Boyle King snakes taken in Washington County. This is an interesting new distribution record for this species in Utah.

Thamnophis ordinoides vagrans (Baird and Girard)

Localities: Torrey, Notom and Fruita, Wayne County; Steep

Creek, West Deer Lake, Cyclone Lake, and Posy Lake, Boulder, Escalante, Bryce Canyon National Park, Tropic and the Junction of Calf Creek and the Escalante River, Garfield County; and Orderville, Kane County. Specimens have been collected by members of all the parties during the course of this study.

Crotalus viridis lutosus Klauber

Localities: Bryce Canyon National Park, Garfield County; Orderville and Kanab, Kane County. Specimens have been collected by V. M. T.

Crotalus viridis decolor Klauber

Localities: Tropic, Escalante Desert, and Escalante River 30 miles below Escalante, Garfield County; Hall Cave, Willow Spring Tank, and Wahweap Creek, Kane County. In 1936 several specimens were taken in the Escalante desert by J. B., V. M. T. and D. E. B.

It is interesting to note the close association of the two species of Rattlesnakes in this area. Specimens taken on top of the Plateau, within Bryce Canyon National Park, are *lutosus* while those taken only fifteen miles to the east in the Paria valley are *decolor*.

SUMMARY

In this preliminary study, biotic information about the Kaiparowits region of south central Utah is presented. The five divisions proposed namely:—the Desert-Prairie Community; the Pinyon-Juniper Association; the Yellow Pine-Oak-Manzanita Community; the Spruce-Balsam-Aspen Association and the Engelmann Spruce-Alpine Association seem to be natural ones, plants and animals being in rather distinct and separate groupings. The majority of the plant and animal species are northern in origin. The southern species are more numerous in the desert and Colorado River portions of this region, suggesting that the Colorado River is serving as a southern portal for the invasion of Sonoran species. As these associtions are studied in more detail it will be possible to divide each one into a number of seres. The springs and seep of the desert and the small running streams of the deep, steep walled canyons and gulleys have hydrophytic serae which seem to support distinct species in separate areas of the region. Xerophytic conditions and species are predominant in the Escalante River area.

In this study 225 species of plants; 24 species of mammals; 42 species of birds; 63 species of insects; 15 species of mollusca; 8 species of amphibians and 19 species of reptiles are reported and asso-

ciated with definite localities and communities. Twelve species of aquatic insects are reported for the first time for the state of Utah.

The Flying Squirrel Collected in Garfield County, Utah

A flying squirrel, *Glaucomys sabrinus lucifugus* Hall, was collected on November 22, 1939, ten miles southwest of Bryce Canyon National Park, Garfield County, Utah, by Mr. Lowell Hansen, who turned the specimen over to the writer. It was submitted to Dr. E. Raymond Hall, acting director of the Museum of Vertebrate Zoology, Berkeley, California, who kindly compared it with the type specimen. Dr. Hall reports as follows concerning his comparison:

"The specimen agrees with *Glaucomys sabrinus lucifugus* in that (1) the breadth of the rostrum (measured at the anterior margins of the anterior palatine foramina) amounts to less than 53 per cent of the length of the nasals, (2) the face is light colored, and (3) the underparts, including the underside of the tail, are light colored. The upper parts, including the upper side of the tail, are darker than in the type specimen but lack the red of *bangsi*. The upper parts match those of a specimen at hand from Camp Tendoy, near Pocatello, Idaho, labeled *bangsi* but which general comparisons indicate is tending toward *lucifugus*. Except in this one feature, darker color of upper parts, the specimen agrees with *G. s. lucifugus*, and this darker color of the upper parts is of slight amount; it may be only individual variation."

According to Dr. Hall's records, this is the fartherest south in the western states this species has been taken, outside of California. This species was first definitely reported as occurring in Utah by the writer in 1927 in the Journal of Mammalogy, Vol. 8, p. 251, as *Glaucomys sabrinus bangsi*. In 1934, in the Occasional Paper, No. 296 of the Museum of Zoology, of the University of Michigan, Dr. E. R. Hall gave the Utah specimens the subspecific name of *lucifugus*. All the specimens collected in Utah previous to this one have been taken in the Uintah and Wasatch Mountains. This new record is 200 miles south in the high Plateaus of Utah. The skin and skull upon which this record is based are now in the mammal collection of the Brigham Young University.—V. M. T.

NEW AMERICAN DIPLOTAXIS (COLEOPTERA SCARABAEIDAE)

MONT A. CAZIER
University of California, Berkeley, Calif.

The following new species were found among material submitted to the writer for determination by various museums and friends. The writer is greatly indebted to the late Mr. H. C. Fall for the privilege of studying his many types in the genus and for a number of specimens presented to the writer. Thanks are also due Dr. P. J. Darlington of the Museum of Comparative Zoology, Cambridge, for permitting the writer to study the Le Conte types in his charge. Individual acknowledgments are to be found under each species.

The descriptions are arranged so that the diagnostic portion includes the main characters used by Fall[1] (1909) in his key. This will enable the reader to refer directly to the most closely allied species.

Diplotaxis impressifrons Cazier, sp. nov.

Medium sized, dark reddish brown; upper surface glabrous; labrum broadly, arcuately emarginate; mentum strongly declivous at anterior third, margin without raised line, setae absent at middle; hind femora with few small punctures, hind coxae sparsely punctate in outer half; prothorax with impressed line along anterior margin.

Head with punctures separated by about their own widths, dense toward clypeus, front shallowly impressed posterior to shallow, post clypeal, obtuse ridge; clypeus densely punctate, punctures coalescent, clypeal suture interrupted medially, clypeal margins evenly, shallowly reflexed, anterior margin truncate, angles evenly rounded, side margins shallowly sinuate, angulate in front of eye; antennae ten-segmented. *Pronotum* with side margins obtusely rounded, widest at middle, front angles rather prominent; surface evenly rather deeply punctate, punctures separated by about their own widths, dense laterally. *Elytra* with distinct costae, intervals irregularly punctate, costae with dorsal row of small punctures; humeral umbone prominent; sides subparallel to apical third. *Beneath* sparsely clothed with short yellow pile; metathorax with both long and short yellow hairs, densely punctate laterally; anterior tibiae tridentate, basal tooth median, tarsal claws with inner, truncate tooth slightly ante-median. Length 11 mm., width 5.5 mm.

Holotype in the writer's collection, taken at Cedarville, Modoc County, California, May 30, 1939 (P. C. Ting, J. A. Downes, T. G. H. Aitken, M. A. Cazier). Collected by beating Juniper at night. One

(1) Fall, H. C., 1909. Revision of the Species of Diplotaxis of the United States. Trans. Amer. Ent. Soc. 35:1-97.

paratype collected in the Warner Mountains, Lake County, Oregon, June 19, 1922 (E. C. VanDyke) deposited in the collection of the California Academy of Sciences. Fifty-seven designated topotypical paratypes deposited in the collections of L. W. Saylor, O. L. Cartwright, M. W. Sanderson, H. J. Reinhard, L. P. Wehrle and the author.

This species appears to be the most closely related to *D. haydeni* Lec. and will key to that species in Fall's paper. It can be distinguished by its dark reddish brown color, less acute anterior thoracic angles, larger and more dense punctuation throughout and by the distinct angulation of the canthus. Occasional specimens have a row of setae across the mental margin and will, therefore, key to *D. parallela* Fall. *Diplotaxis impressifrons* can be distinguished from this species by its darker color, robust shape, deeper, more dense punctuation, by having the sides of the pronotum less abruptly constricted anteriorly and the pronotal angles less produced.

Diplotaxis saylori Cazier, sp. nov.

Medium sized, robust; elytra sub-connate, wings rudimentary; color dark brown, opaque; upper surface glabrous; labrum broadly, arcuately emarginate; mentum flat posteriorly, distinctly declivous at anterior third, declivity margined by acute, arcuate raised line and a row of erect setae; thoracic angles not impressed, sides not bisinuate; front without post-clypeal convexity; metasternum short, length between coxae equal to length of second abdominal segment.

Head broad, vertex with small smooth area, front rather deeply, densely punctate; clypeus with punctures large, nearly coalescent, front margin evenly reflexed, shallowly emarginate medially, side margins sinuate anterior to clypeal suture, abruptly angulate in front of eyes, clypeal suture distinct throughout; antennae nine-segmented. *Pronotum* shallowly convex, side margins evenly rounded, widest at middle, prominent, almost reflexed; surface sparsely, shallowly punctate, punctures separated by about twice their own widths, median impression shallow, smooth posteriorly. *Elytra* with humeral umbones reduced but evident, sides evenly rounded; surface without distinct costae, punctures of first interval irregular, remainder arranged in rows, punctures shallow, separated by about twice their own widths. *Beneath* sparsely clothed with short yellow pile; legs with all tarsi setiferous, claws cleft at apex, inner tooth the shortest, hind femora with upper surface sparsely, finely punctate medially, anterior tibiae tridentate, basal tooth small, ante-median in position. Length 12 mm., width 6 mm.

Holotype from Oak Flat, Mt. Graham, Arizona, June 27, 1919 (A. Wetmore) returned to L. W. Saylor of the United States Biological Survey for Deposition in the United States National Museum. One paratype from Graham Mts., Arizona, altitude 9200 ft., June 13, 1914 (E. G. Holt) in the writer's collection. The writer takes pleasure in naming the species after L. W. Saylor who has done much to further

the knowledge of the Scarabaeidae and who gave the specimens to the writer for description.

As can be seen from the diagnostic characters *D. saylori* belongs with *D. connata* Schffr. and *D. macronycha* Fall in Fall's key. It appears to be most closely related to these species but is easily separated. It can be separated from both species by its larger size, brown color, broad, flattened pronotum, small humeral umbones, the smaller, sparser punctuation of the pronotum and by the nine-segmented antennae. From *D. connata* it can be further distinguished by the broadly reflexed clypeus, abrupt angulation of the canthus in front of the eye, prominent side margins of the pronotum and the small, sparse punctures of the hind femora. In *D. connata* the punctures of the hind femora are larger, rather deep, distinctly elongate and more abundant. *Diplotaxis saylori* can be separated from *D. macronycha* by its distinct clypeal suture, angulation of canthus anterior to the eye, the evenly rounded side margins of the pronotum, the antemedian front tibial tooth and by the apically cleft tarsal claws.

Diplotaxis aequalis Cazier, sp. nov.

Medium sized, dark brown; upper surface glabrous; labrum broadly arcuately emarginate; mentum nearly flat posteriorly, declivous in front, the declivity margined by arcuate raised line and row of erect setae; thoracic angles not impressed, sides not bisinuate; front nearly flat; metasternum longer than length of second abdominal segment; ungual tooth strongly post-median; clypeal margin only slightly emarginate, nearly truncate; ungual tooth subapical; sides of prothorax moderately arcuate, only slightly narrowed behind middle; clypeus nearly flat; punctures of head close; punctures of elytral disk broadly confused, interstices of punctures devoid of minute punctuation; front bi-impressed between eyes; labrum broadly impressed; claws similarly toothed in both sexes.

Head with punctures on front separated by about one-half their own widths; clypeus with front margin shallowly reflexed, side margins shallowly sinuate, angulate in front of eyes, surface with deep punctures, nearly confluent; clypeal suture entire; antennae ten-segmented. *Pronotum* with side margins prominent, widest at middle; posterior margin wider than anterior; upper surface with shallow median impression, punctures rather deep, separated by about their own widths, dense laterally, a shallow impression in front of middle laterally. *Elytra* with costae evident, punctures rather irregular, interspaces irregularly punctured, punctures separated by about three times their own widths, surface irregular between punctures, minutely alutaceous. *Beneath* sparsely clothed with short yellow pile; hind coxae rather densely punctate, basal tooth of front tibiae slightly antemedian, hind femora sparsely punctate throughout; tarsal claws cleft subapically, inner tooth obliquely truncate, equal in length to outer tooth, hind tarsi as long as hind tibiae. Length 12 mm., width 6 mm.

Holotype in the writer's collection, taken at Globe, Arizona, July 27, 1935 (F. H. Parker). Two paratypes from Pinal Mountains, Ari-

zona, August 23, 1935 (F. H. Parker) and one from Pinal Mountains, Arizona, May 22, 1938 (F. H. Parker) deposited in the collections of Frank H. Parker and O. L. Cartwright. One paratype from Prescott, Arizona, April 1919 (A. Kusche) in the collection of the California Academy of Sciences. One paratype from Pinal Mountains, Arizona (C. W. Leng) in the writer's collection.

This species is apparently most closely allied to *D. anthracina* Fall to which it runs in Fall's key. It can be readily separated from *D. anthracina,* however, by its brown color, larger size, longer tarsi, larger pronotal punctures, flattened front of the head, the larger punctures of the elytra and by the roughened elytral surface. Superficially *D. aequalis* resembled *D. peninsularis* Fall but can be distinguished from it by the key difference, by the less emarginate front margin of the clypeus, the longer clypeus, less closely punctate front and pronotum and by the irregular elytral surface.

The writer is indebted to Frank Parker for the privilege of studying specimens in his extensive collection of Arizona insects.

DIPLOTAXIS FULGIDA Cazier, sp. nov.

Small, light reddish yellow, shining; glabrous above; labrum broadly arcuate; mentum declivous in front, the declivity margined by acute raised line and setae; thoracic angles not impressed, sides not bisinuate; front without convexity; metasternum longer than length of second abdominal segment; ungual tooth postmedian; clypeal margin truncate; mental ridge well defined; base of pronotum without impressed line; antennae ten-segmented; front and clypeus densely punctate.

Head with punctures dense on front, often confluent; clypeal suture narrowly interrupted medially, impression distinct; clypeus narrowed in front, margins shallowly reflexed, side margins not sinuate, no angulation in front of eyes. *Pronotum* widest at middle, broadly rounded behind, gradually narrowed anteriorly; front and hind margins equal in width; surface with median punctures separated by about twice their own widths, dense laterally. *Elytra* with costae evident, intercostal spaces irregularly punctate, surface between punctures broadly wrinkled, smooth. *Beneath* clothed with short yellow pile; front tibiae with basal tooth median, hind coxae punctate, hind femora with few small irregular punctures. Length 6 mm., width 3 mm.

Holotype in the author's collection, taken in Smith County, Texas, June 1, 1937 (W. L. Owen Jr.) in a Texas Agricultural Experiment Station Light Trap. Four designated topotypical paratypes in the Texas Agricultural Experiment Station collection. One paratype from McLennan County, Texas, June 7, 1934 (F. F. Bibby) in the writer's collection. The writer is indebted to Dr. H. J. Reinhard for the opportunity of studying the material in his charge.

This species keys to *D. arcuata* Fall but can at once be separated

from that species by its smaller size, shining appearance, deep elytral punctures, by the raised areas between the elytral punctures and by the distinct elytral costae. From *D. dubia* Lec. it can be distinguished by the shape of the pronotum, the less densely punctate pronotum, more constricted clypeus and by having the male tarsi devoid of extra hair.

DIPLOTAXIS ACONONICUS Cazier, sp. nov.

Medium sized, reddish brown, alutaceous; upper surface glabrous; labrum arcuately emarginate; mentum strongly concave beginning at basal third, without trace of transverse ridge; punctuation sparse, punctures separated by about their own widths; angles of prothorax not impressed.

Head convex in front, punctures separated by about their own widths, densely placed toward clypeus; clypeal suture distinct throughout, front margin shallowly emarginate, narrowly reflexed, punctures separated by about one third their own widths, side margins not on same plane as canthi; canthi obtusely angulate in front of eyes; antennae ten-segmented. *Pronotum* about one and one-half times wider than long, side margins evenly, arcuately rounded, widest near base; surface with shallow, medium sized punctures separated by about their own widths. *Elytra* without elevated costae; strial punctures irregularly placed and of varying sizes and shapes, all punctures separated by about their own widths. *Beneath* sparsely clothed with yellow pile, hind coxae punctate; legs with hind femora sparsely punctate, claws with short, truncate anti-median tooth, front tibiae with basal tooth barely anti-median in position. Length 9.5 mm., width 5 mm.

Holotype in the writer's collection, taken in the Huachuca Mountains, Arizona, September 17, 1935 by F. H. Parker who kindly presented the specimen to the writer.

Diplotaxis acononicus is closely allied to *D. parvicollis* Fall but can be separated from that species by the angulate canthi, larger and more dense punctuation of the head and clypeus, less constricted front angles of the pronotum, the larger and more dense punctuation of the pronotum and by the lack of well defined elytral costae. In *D. parvicollis* the lateral margins of the clypeus are on the same plane as the canthi although there is a shallow sinuation immediately in front of the canthi.

DIPLOTAXIS AULACOCHELA Cazier, sp. nov.

Medium sized, head and pronotum piceous, elytra dark reddish brown, shining; upper surface glabrous; labrum deeply divided; mentum excavated in front; front feebly impressed.

Head with front densely punctate, punctures separated by less than their own widths above, nearly coalescent below; clypeus with front margin narrowly reflexed, shallowly emarginate medially, side margins continuous with canthi, clypeal suture interrupted at middle, impression distinct throughout; antennae ten-segmented. *Pronotum* with side margins obtusely angulate medially, widest at mid-

dle; front and hind margins subequal in width, front margin sinuate, slightly produced medially; surface irregularly punctate, punctures separated by one to two times their own widths, dense laterally, interspaces smooth, shining, anterior angles with an oblique, shallow impression behind, surface depressed along side margins. *Elytra* with costae well defined, only first intercostal space irregularly punctate, interspaces flat and smooth, punctures separated by about twice their own widths. *Beneath* sparsely clothed with short yellow pile, hind coxae punctate; legs with hind femora irregularly, sparsely punctate, front tibiae with basal tooth median in position, claws with subapical truncate tooth, tarsi short. Length 9 mm., width 4.7 mm.

Holotype in the collection of the Texas Agriculture Experiment Station, taken at Presidio, Texas, June 28, 1930 (W. L. Owen Jr.) and kindly loaned to the writer by H. J. Reinhard.

This species is most closely allied to *D. fissilabris* Fall but can readily be separated from it by the reddish brown elytra, shining appearance, by lacking the sinuate side clypeal margins, by having the anterior pronotal angles more pronounced, the pronotal surface irregular punctuate with the intervals flat and smooth, and the elytral surface smooth with punctures separated and no irregular impressions present. In *D. fissilabris* the pronotum is rather evenly punctured, the surface between the punctures is minutely alutaceous and sparsely covered with small punctures, the elytral interspaces have irregular impressions that often connect the punctures with one another thus giving the surface a rough, dull appearance.

Diplotaxis ungulatus Cazier, sp. nov.

Medium sized, dark reddish brown, shining; upper surface glabrous; labrum broadly, arcuately emarginate; mentum strongly declivous from apical third, without raised line or setae; hind femora nearly impunctate, tooth of tarsal claws median in position; hind coxae nearly impunctate.

Head with impunctate area on vertex, front sparsely, minutely punctate above, more densely punctate below where punctures are shallow and separated by about their own widths; clypeus with anterior margin rather broadly flexed, shallowly emarginate, side margins shallowly sinuate in front of eye, surface with shallow punctures separated by about their own widths, clypeal suture distinct throughout; antennae ten-segmented. *Pronotum* about twice as broad as long, side margins evenly arcuately rounded, widest at middle, angles obtuse; front margin little narrower than hind margin; surface finely alutaceous, punctures small, separated by about twice their own widths. *Elytra* with costae well defined, intercostal spaces finely alutaceous, irregularly punctate, punctures separated by about twice their own widths. *Beneath* with metasternum sparsely punctate laterally, impunctate medially; legs with basal tooth of front tibiae median in position, tarsi longer than tibia, claws two-thirds the length of fifth tarsal segment. Length 10 mm., width 5 mm.

Holotype in the writer's collection, taken in the White Mountains,

Arizona, July, 1930 by D. K. Duncan and kindly presented to the writer by F. H. Parker.

Most closely allied to *D. levicoxa* Fall but distinguishable by its smaller size, narrow form, shallow, sparsely punctate front and clypeus, continuous clypeal suture, sinuate side clypeal margins, evenly rounded canthi, by the lack of the small punctures of the elytral interspaces and by the longer hind tarsi. In *D. levicoxa* the side margins of the clypeus are not sinuate, the canthi are angulate, the elytral interspaces are minutely punctate and the hind tarsi are shorter than the tibiae.

DIPLOTAXIS PERSISAE Cazier, sp. nov.

Medium sized, head and pronotum black, elytra piceous; upper surface glabrous; labrum broadly arcuately emarginate; mentum nearly flat posteriorly, strongly concave from basal third; punctuation of upper surface rather dense.

Head with front shallowly convex, punctures small, separated by about their own widths; clypeus with front margin narrowly reflexed, shallowly emarginate medially, side margins straight, canthi obtusely rounded, clypeal suture not interrupted, impression prominent, flattened, sparsely punctate; antennae ten-segmented. *Pronotum* with side margins evenly, arcuately rounded, widest at middle; front angles deeply impressed, hind angles shallowly but broadly impressed, surface of impressed area rough, opaque; surface with punctures separated by about their own widths, interspaces finely punctate. *Elytra* with costae well defined, intercostal spaces wide, irregularly punctate, punctures separated by about one and one-half times their own widths. *Beneath* sparsely clothed with short yellow pile; legs with hind coxae punctate, hind femur sparsely punctate on inner surface, front tibiae shallowly tridentate, basal tooth slightly in front of middle, tarsal claws cleft subapically, inner tooth truncate, short, hind tarsi about two-thirds as long as tibiae. Length 9 mm., width 4.5 mm.

Holotype in the writer's collection, taken in the Chiricahua Mountains, Arizona, September 14, 1935 by F. H. Parker. The writer is pleased to name this species in honor of Mrs. F. H. Parker who has contributed much to the knowledge of the insect fauna of Arizona through her collecting efforts.

Diplotaxis persisate is apparently most closely allied to *D. costulata* Fall but can be readily separated by its smaller size, unimpressed front, impressed front angles of pronotum, impressed, opaque hind pronotal angles, more widely separated punctures and by the shorter tarsi. From the other four species in this section, *D. brevicollis* Lec., *D. semifoveata* Fall, *D. parvicollis* Fall, and *D. acanonicus* Cazier it can be distinguished by the opaque impressed hind pronotal angles and the larger and more dense punctuation throughout.

DIPLOTAXIS PARKERI Cazier, sp. nov.

Medium sized, shining black; upper surface glabrous; labrum broadly arcu-

ately emarginate; mentum declivous from anterior third, the declivity margined posteriorly by an acute raised line and a row of erect setae; thoracic angles not impressed, sides not bisinuate; front without post-clypeal convexity; metasternum longer than second abdominal segment; ungual tooth subapical; clypeal margin scarcely emarginate medially; sides of pronotum strongly arcuate, widest at middle; tarsi not hairy beneath, all claws similarly toothed.

Head with front rather densely, deeply punctate below, punctures separated by about one-half their own widths, above by about their own widths, front shallowly impressed on each side of median line; clypeus with front margin broadly reflexed, angles obtusely rounded, side margins continuous with canthi, not sinuate, surface deeply, densely punctate, clypeal suture distinct throughout; antennae ten-segmented. *Pronotum* with posterior margin slightly wider than anterior margin, surface smooth, punctures deep, separated by about twice their own widths, scarcely more abundant laterally. *Elytra* with costae obscure except for row of small median punctures, first intercostal space irregularly punctate, second with an irregular single row. *Beneath* sparsely clothed with short yellow pile; legs with hind femora sparsely punctate, hind coxae densely punctate, front tibiae tridentate, basal tooth median in position, posterior tarsi as long as tibiae. Length 11 mm., width 5.5 mm.

Holotype in the writer's collection, taken in the Pinal Mountains, Arizona, May 19, 1935 by F. H. Parker in whose honor the writer is pleased to name the species. One topotypical paratype in the collection of F. H. Parker.

Although *D. parkeri* runs to *D. acerba* Fall in Fall's key it is in reality, more closely allied to *D. anthracina* Fall. It can be distinguished from *D. acerba* by its larger size, black color, bi-impressed front, unsinuate side clypeal margins, single irregular row of punctures in second costal interval and by the longer tarsi. From *D. anthracina* it can be separated by its more elongate clypeus, bi-impressed front, more angulate pronotal side margins, larger pronotal and elytral punctures, by having only a single irregular row of punctures in the second costal interval and by having the basal tooth of front tibiae median in position. In *D. anthracina* the second costal interval has two irregular rows of punctures and the basal front tibial tooth is distinctly nearer the apex than the base.

Diplotaxis microps Cazier, sp. nov.

Small, narrow, rufotestaceous; upper surface glabrous; labrum broadly arcuately emarginate; mentum declivous in front, posterior margin of declivity with acute raised line and row of erect setae; thoracic angles not impressed, sides not bisinuate; front without post-clypeal convexity; metasternum longer than second abdominal segment; ungual tooth subapical; clypeal margin angulate on each side of shallow medin emargination; tarsal segments not conspicuously hairy beneath; punctures of elytral intercostal spaces confused; elytra with minute alutaceous sculpturing.

Head with front densely punctate throughout, punctures coalescent or narrowly separated; eyes exposed for about the same distance as width of canthi; clypeus strongly flexed, side margins nearly straight, strongly angulate and connecting with canthi at point of angle, surface with median punctures indistinct, edges with coalescent punctures; clypeal suture absent except for small smooth spot at corner of eye on junction of front and clypeus; antennae short, nine-segmented. *Pronotum* with sides rather strongly, obtusely angulate, widest at middle, more strongly constricted behind middle; anterior margin as wide as posterior, shallowly emarginate medially; surface with punctures separated by about their own widths, dense laterally, interspaces with small punctures interspersed; disk with small spot devoid of large punctures, sparsely covered with small punctures. *Elytra* with costae indistinct, punctures on top of costae irregular and nearly as large as strial punctures, first intercostal space punctures separated by about twice their own widths, those of second by about their own widths. *Beneath* clothed with short yellow pile; legs with hind femora sparsely punctate with large punctures, hind coxae and metasternum densely punctate, front tibiae with basal tooth median in position, hind tarsi with first segment about half length of second, hind tarsi subequal in length to hind tibiae. Length 7 mm., width 3.5 mm.

Holotype in the author's collection, taken at Cochise Stronghold, Cochise County, Arizona, April 29, 1938 (H. F. Tate) and very kindly presented to the writer by Dr. L. P. Wehrle. Paratopotype in Dr. Wehrle's collection at the University of Arizona. A third damaged specimen in the collection of the Southern California Academy of Sciences was collected in Sabino Canyon, Santa Catalina Mountains, Ariozna, June 10, 1919 (D. Roberts) and was kindly loaned to the writer by Dr. W. D. Pierce of that institution.

The paratype specimen is like the holotype in all major features except for size. It measures 9 mm. in length, 4.2 mm. in width and may possibly be the female of this species. The third specimen is intermediate in size between the other two.

In Fall's key *D. microps* will run to *D. errans* Fall but is readily distinguishable from that species by its wider mental declivity, unsinuated side clypeal margins, lack of the clypeal suture, the small eyes, by the median position of the basal tooth on the front tibiae and by its shorter, nine-segmented antennae.

A brief note attached to the type by Dr. Wehrle indicates that this species does some damage to peach trees and other deciduous fruits. The adults hide in the soil near the trunks of the trees during the day and come out at night to feed on the young growth. This is one of few reported cases of members of this genus doing damage to cultivated plants.

Diplotaxis recticanthus Cazier, sp. nov.

Small, narrow, rufotestaceous; upper surface glabrous; labrum broadly, arcu-

ately emarginate; mentum declivous at anterior third, declivity margined behind by an acute raised line and row of setae; thoracic angles not impressed, sides not bisinuate; front without post-clypeal convexity; metasternum longer than second abdominal segment; ungual tooth subapical; clypeal margin distinctly angulate on each side of middle sinuation, the angles rather sharply defined, not dentiform; tarsi not conspicuously hairy beneath; elytral punctuation confused in all intercostal spaces, with indication of minute alutaceous sculpturing; pronotum widest a little behind the middle; eyes small.

Head with punctures large and dense, separated by less than one-half their own widths or coalescent; eyes little wider than angulation in front composed of canthi and clypeus; clypeus with front margin broadly flexed, side margins scarcely flexed; side margins bisinuate, posterior angles rounded, protruding outward beyond anterior angles of canthi which are obtusely angulate, clypeal suture evident only laterally; antennae ten-segmented. *Pronotum* widest a little behind the middle, posterior portion more strongly constricted than anterior, posterior margin about same width as anterior margin; surface with punctures separated by about their own widths, interspaces finely punctate. *Elytra* with costae distinct, punctures of intercostal spaces separated by about their own widths, second intercostal space with two and three irregular rows of punctures. *Beneath* sparsely punctate and clothed with short yellow pile; legs with hind femora impunctate, front tibia with basal tooth short, median in position. Length 7.5 mm., width 3.8 mm.

Holotype in the writer's collection, taken in the White Mountains, Arizona, September (D. K. Duncan) and very kindly given to the writer by F. H. Parker.

Diplotaxis recticanthus will run to the dichotomy including *D. punctata* Lec. and *D. chiricahuae* Fall in Fall's key but can be separated from either of these species by the small eyes, the angulate canthi, the broadly flexed anterior clypeal margin, and the bisinuate side clypeal margins. It appears to be most closely allied to *D. deserta* Fall, which also belongs in this group, but can be distinguished by its larger size, darker color, more prominently reflexed front clypeal margin, strongly angulate canthi, smaller eyes, larger pronotal and elytral punctures and by the double, irregular rows of punctures in the second intercostal space. From *D. pinalica* Fall it can be distinguished by its small eyes, more reflexed front clypeal margin, obscure clypeal suture, angulate canthi, by having the interspaces of the pronotum finely punctate, and by the less alutaceous sculpturing of the elytra.

Diplotaxis brevicornis Cazier, sp. nov.

Small, narrow, rufotestaceous; upper surface glabrous; labrum broadly arcuately, emarginate; mentum declivous in front, declivity margined posteriorly by rather indistinct raised line and row of erect setae; thoraic angles not impressed, side margins not bisinuate; front without post-clypeal convexity; metasternum longer than second abdominal segment; ungual tooth apical; clypeal margin an-

gulate on each side of median sinuation; tarsi not conspicuously hairy beneath; elytral punctuation confused only in the subsutural area, elsewhere arranged in nearly regular series; interocular width of front about three times the width of the eye.

Head with punctures of front separated by about their own widths; clypeus more densely punctate, front margin broadly flexed, side margin less so, shallowly sinuate, canthi angulate before junction with clypeal margins; antennae ten-segmented, club short, equal in length to terminal segment of maxillary palpi. *Pronotum* with side margins arcuately rounded, widest slightly behind middle, posterior portion more strongly constricted than anterior; posterior margin sub equal in width to anterior margin; surface with punctures somewhat irregular, generally separated by about their own widths, interspaces with smaller punctures. *Elytra* alutaceous, punctures not well defined, separated by about twice their own widths. *Beneath* sparsely clothed with short yellow pile, sparsely punctate throughout, laterally the punctures are separated by at least their own widths; legs with hind femora impunctate, hind coxae punctate, anterior tibiae with basal tooth median in position, posterior tarsi as long as tibiae, inner tooth of claws apical, scarcely truncate. Length 6 mm., width 3 mm.

Holotype in the collection of the Southern California Academy of Sciences, taken at Pyramid Peak, Dona Ana County, New Mexico, August 8, 1930 (F. R. Fosberg) and kindly loaned to the writer by Dr. W. D. Pierce. Twenty-three topotypical paratypes deposited in the same collection as the holotype and in that of the writer.

This species is most closely allied to *D. misella* Fall but can be distinguished by its less acute anterior clypeal angles, smaller and less dense pronotal and elytral punctuation and by its shorter antennal club.

NOTES ON THE HERPETOLOGICAL SPECIMENS ADDED TO THE BRIGHAM YOUNG UNIVERSITY VERTEBRATE COLLECTION DURING 1939[1]

WILMER W. TANNER
In charge of Biological Science
Provo High School, Provo, Utah

During the season of 1939 considerable herpetological collecting was done by the Zoology staff of the Brigham Young University. Collecting parties visited many parts of the state of Utah and adjoining states. Considerable time and effort was spent in an attempt to collect those specimens which were not well represented in the herpetological collection of the University. This goal, while not completely reached, was brought much closer to a point of realization. Several of the species which had been considered as rare Utah reptiles, were found to be quite numerous, for example, fifteen (15) specimens of *Hypsiglena ochrorhynchus* Cope were taken from many localities throughout the wide area covered. Also, this extensive collecting has provided us with a number of important notes, some of which are included in this report. Emphasis has been placed on obtaining information on the feeding and reproduction habits of our more common species.

The specimens collected to date indicate two interesting points in connection with the distribution of reptiles in Utah. First, Utah is an area in which the distribution limits of many forms is reached. The Smooth-grass snake *(Opheodrys vernalis)* and the Red-barred garter snake *(Thamnophis s. parietalis)* have invaded the state from the east and north. To the south we have at least sixteen (16) species which are found in only a narrow margin of Utah, principally Washington, Kane and San Juan counties. Second, only a few species appear to have a state-wide distribution. Such an interesting distribution is explained in part, by the great variety of environmental habitats.

The following collectors are responsible for the large number of specimens collected: Dr. Vasco M. Tanner, Dr. D. Eldon Beck, James Bee, Eldon Randall, Burton Hunt, and the writer. I wish also, to thank Mr. H. V. Walker, Zion National Park Naturalist, for the material and notes contributed by him.

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(1) Contribution No. 84, Department of Zoology and Entomology, Brigham Young University.

LIST OF SPECIES

AMBYSTOMA TIGRINUM (Green)

Helper, Carbon County, Utah; Junction of Steamboat and North Umpqua Rivers, Douglas County, Oregon.

SCAPHIOPUS INTERMONTANUS (Cope)

Helper and Price, Carbon County; Fairfield, Utah County, Utah.

The specimen taken at Fairfield is one of the few specimens taken in this part of the state. Its morphology is typical for the Utah forms.

BUFO BOREAS BOREAS (Baird and Girard)

Fairview, Sanpete County, Utah; Fairfield, Camas County, Idaho; Glide, Douglas County, Oregon.

BUFO WOODHOUSII Girard

Fairfield, Utah County, Utah.

PSEUDACRIS NIGRITA TRISERIATA (Wied)

Delco, Cassia County, Idaho.

HYLA ARENICOLOR Cope

Zion National Park, Washington County, Utah.

RANA AURORA AURORA (Baird and Girard)

Hoods Canal, Seabeck, Kitsap County, Washington.

RANA BOYLII BOYLII (Baird)

Junction Steamboat, North Umpqua Rivers, Douglas County, Oregon.

RANA PIPIENS Schreber

Fairfield, Utah County; Fairview, Sanpete County; Redmond, Sevier County; Helper, Carbon County; Castle Dale, Emery County, Utah. Delco, Cassia County, Idaho.

This species is the most common frog in Utah. It has a state wide distribution.

RANA PRETIOSA PRETIOSA (Baird and Girard)

Fairview, Sanpete County, Utah; Pine, Gila County, Arizona.

The record from Fairview extends the known range of this species in Utah. I found them quite numerous in this area.

Three specimens were taken at Pine, Gila County, Arizona, by Burton Hunt, July 7, 1939. These specimens, while showing some variations, are quite the same as those taken in Utah Counay, Utah. This record greatly extends the known range for this species. Until these records were taken no specimens had been collected south of Utah County. So far as the writer knows this is a new state record for Arizona.

Crotaphytus collaris baileyi (Stejneger)

Chimney Rock Pass, Utah County; White Valley, Millard County, Utah.

Crotaphytus wislizenii Baird and Girard

Chimney Rock Pass, Utah County; ten miles north of Lyndyl, Juab County; White Valley, Millard County; Desert near Lund, Iron County, Utah.

Sauromalus obesus (Baird)

Boulder Dam, Clark County, Nevada.

Uta levis Stejneger

Price Canyon above Castle Gate, Standardville, Carbon County; Buckhorn Wash, San Rafael, Emery County, Utah.

Uta ornata symmetrica (Baird)

Pine, Gila County, Arizona.

Uta s. stansburiana (Baird and Girard)

Chimney Rock Pass, and four miles west of Lehi, Utah County; Price, Carbon County, Utah.

Sceloporus undulatus consobrinus (Baird and Girard)

Pine, Gila County, Arizona.

Sceloporus undulatus elongatus (Stejneger)

Price, Standardville, and Peerless Mine, Carbon County; Buckhorn Wash, San Rafael, Emery County, Utah.

Sceloporus occidentalis biseriatus (Hallowell)

Chimney Rock Pass, Utah County; White Valley, and the craters west of Fillmore, Millard County, Utah.

Sceloporus g. graciosus (Baird and Girard)

Price, Standardville, and Price Canyon, Carbon County; Castle Dale, Emery County; four miles west of Lehi and West Canyon, Utah County; Zion National Park, Washington County; ten miles north of Lyndyl, Juab County; Cove Fort and White Valley, Millard County; and Fairview, Sanpete County, Utah. Rexburg, Madison County, Idaho.

This species is distributed over the entire state of Utah. No other lizard is so widely distributed or common throughout the state. The distribution limits for this species are not well defined. It does, however, occur in all adjoining states.

Sceloporus graciosus gracilis (Baird and Girard)

Junction of Steamboat and the North Umpqua Rivers, Douglas County, Oregon.

Sceloporus magister Hallowell

Cactus Flats on Highway 91, Washington County, Utah.

Phrynosoma douglassii ornatissimum (Girard)

Willow Creek, Duchesne County; Near Kyune, Utah - Carbon County lines; Fairview, Sanpete County, Utah.

Phrynosoma douglassii ornatum (Girard)

Four miles west of Lehi, Utah County; Fort Douglas, Salt Lake County, Utah.

Phrynosoma platyrhinos Girard

Four miles west of Lehi, Chimney Rock Pass, Utah County; Cactus Flats, on Highway 91, Washington County, Utah.

Phrynosoma douglassii hernandesi (Girard)

Pine, Gila County, Arizona.

Gerrhonotus multicarinatus scincicauda (Skilton)

Glide, Douglas County, Oregon.

Cnemidophorus t. tessellatus (Say)

Chimney Rock Pass, Utah County, Utah.

Cnemidophorus perplexus Baird and Girard

Zion National Park, Washington County, Utah.

Cnemidophorus sexlineatus (Linne)

Gary, Lake County, Indiana.

Eumeces fasciatus (Linne)

Reelfoot Lake, Obion County, Tennessee.

Eumeces s. skiltonianus (Baird and Girard)

West Canyon (Cedar Valley) and Diamond Fork Canyon, Utah County, Utah. Junction of Steamboat and North Umpqua Rivers, Douglas County, Oregon.

Charina bottae (Blainville)

Provo Canyon and American Fork Canyon, Utah County, Utah.

Diadophis regalis regalis (Baird and Girard)

Circleville, Piute County, Utah; Preston, Franklin County, Idaho.

The Idaho record is, so far as the writer is aware, the first time this species has been reported from that state. It was collected by a student on April 20, 1939. The specimen was later given to Dr. J. S. Stanford of the Utah State Agricultural College at Logan, Utah. Dr. Stanford permitted the writer to study it. The specimen does not differ in any important details from those specimens collected in southern Utah. The scale county are: scale rows 17-17-15; ventrals 226;

candals 64; supra-labials 7-7; infra-labials 7-8; post-oculars 2-2; pre-oculars 2-2; loreal 1-1; temporals 1-1; total length 526 mm.

At this time I also wish to report a specimen collected by Dr. J. S. Stanford and students in the Deep Creek Mountains, Juab County, Utah. These northern records would indicate that *Diadophis r. regalis* has an extensive distribution over the entire state of Utah and Southern Idaho. An interesting observation on the feeding habits of the *Diadophis r. regalis* was made by Mr. H. V. Walker, who found a large specimen in Zion National Park feding on a small *Pituophis c. deserticola.*

Opheodrys vernalis (Harlan)

Payson Canyon, Utah County, Utah.

Opheodrys aestivus (Linne)

Reelfoot Lake, Obion County, Tennessee.

Coluber c. mormon (Baird and Girard)

Logan, Cache County; Fort Douglas, Salt Lake County; Farmington, Davis County; four miles west of Lehi, Utah County, Utah. Caldwell, Canyon County, Idaho.

Coluber t. taeniatus (Hallowell)

Chimney Rock Pass, and four miles west of Lehi, Utah County; Buckhorn Wash, San Rafael, Emery County, Utah.

Coluber flagellum frenatus (Stejneger)

St. George, Washington County, Utah.

Salvadora g. hexalepis (Cope)

Zion National Park, Washington County, Utah.

During a short stay at Zion National Park, May 1-2, 1939, the writer examined the herpetological specimens found in the park museum. A specimen labeled "Bull Snake," which was said by the park official to have ben collected in the park, proved to be a fine specimen of *Salvadora grahamiae hexalapeis* (Cope). No data, date or collector's name had been recorded. A second specimen was collected by Mr. H. V. Walker, Park Naturalist, during the summer of 1939. It was taken on the lawn a short distance below the park museum. Later in the summer this specimen was lost. More recently, May 15, 1940, Mr. Walker collected a third specimen, near the Park museum. I have studied these two specimens and find them to conform with other specimens taken in southern Utah. In both the scale rows are: 19-17-13; ventrals 198 and 191; candals 81, the last specimen collected has a broken tail. Supra-labials 9-9; infra-labials 10-10; pre-oculars 2-2 and 3-3; post-oculars 2-2, in both. Total lengths 705 and 650. The

largest Utah specimen studied by the writer is the one from the park. Both specimens are females. The finding of the Patch-nose snake in Zion National Park is a new reptile record for the Park.

Available records for Utah now total eight (8), seven (7), of which have been taken in Washington County, the other specimen is listed for Cottonwood Canyon, presumably Salt Lake County, Utah.

Pituophis catenifer deserticola Stejneger

Thistle Canyon; Chimney Rock Pass, four miles west of Lehi, Utah County; Fort Douglas, Salt Lake County; Levan and ten miles north of Lynndyl, Juab County; Price, Carbon County; Sterling Reservoir, Sanpete County; Marysvale Canyon, Sevier County; Milford, Millard County; Logan and Smithfield, Cache County, Utah. Swan Lake and Pocatello, Bannock County; Colsom Creek, Salmon River, Lemhi County, Idaho.

Lampropeltis getulus boylii (Baird and Girard)

Hurricane, Washington County, Utah.

Lampropeltis triangulum gentilis (Baird and Girard)

Alpine and Lehi, Utah County; Mt. Pleasant, Sanpete County, Utah.

Specimens have been collected in eleven of the twenty-nine counties of Utah, extending from Tooele on the northwest to Washington on the southwest and to Uintah on the northeast. From our records it appears that this species, while not numerous or common in any part of the state, has a state wide distribution.

Rhinocheilus lecontei Baird and Girard

On August 8, 1939, Mr. Reed Fautin collected a specimen of *Rhinocheilus lecontei*, in White Valley, Millard County, Utah. The specimen was taken in the evening as it was moving from one clump of desert shrub to another. Mr. Fautin recently collected a second specimen also in White Valley. The specimen collected in August, 1939, was contributed to the Brigham Young University collection by Mr. Fautin. These specimens extend the range of the Long-nose snake well into the upper Sonoran Zone of Utah.

While discussing the Long-nose snake I wish to make a correction to Mr. Ross Hardy's statement concerning the known records for Utah. He writes, "A long-nose snake was taken May 19, 1939, at Veyo, Washington County. This is the second record of this species for the state of Utah." (Proceedings Utah Academy of Sciences, Arts and Letters, Vol. 16, 1939.) In 1935 Dr. Vasco M. Tanner, reporting on the "Western Wormsnake, *Siagonodon humilis* (Baird and

Girard), found in Utah." (Utah Academy of Sciences, Arts and Letters, Vol. 12) reported three specimens for the St. George region. One specimen collected in 1917 by Dr. Tanner is in the California Academy of Science collection. Thus from available records, six specimens of the Long-nose snake have been taken in Utah, four from the St. George area, and two from western Millard County, Utah.

At this time I also wish to report a specimen of *Rhinocheilus* taken by the writer on the road two miles south of Bunkerville, Clark County, Nevada, April 28, 1940.

Sonora s. semiannulata (Baird and Girard)

During the summer of 1938 a specimen of Sonora was taken in the park by Mr. H. V. Walker. Since then several specimens have been collected. One of my students found a complete Sonora skin in the grass near the museum. The scale counts for the specimens examined are identical with those collected near St. George, Washington County, Utah. A specimen taken about ten miles above Lake Mead on the Virgin River by Dr. J. S. Stanford, also has a very close resemblance to the St. George specimens.

The Sonora is also a new record for Zion National Park.

Thamnophis eques (Reuss)

Pine, Gila County, Arizona.

Thamnophis ordinoides ordinoides (Baird and Girard)

Anacortes and Bellingham, Walsom County; Seabeck, Kitsap County, Washington. Glide, Douglas County, Oregon.

Thamnophis o. vagrans (Baird and Girard)

Sterling Reservoir and Fairview, Sanpete County; Price, Carbon County; Castle Dale, Emery County; West Canyon, Cedar Valley, Utah County, Utah. Science Lodge, twenty-eight miles west of Boulder County, Colorado.

This species is distributed over the entire state of Utah, from which it overlaps into all adjoining states. Just where its limits of distribution and areas of intergradation are is not as yet clear. Utah, however, might well be considered the area providing the most typical specimens from the *vagrans* species.

Thamnophis sirtalis concinnus (Hallowell)

Junction, Steamboat and the North Umpqua Rivers, Douglas County, Oregon.

Thamnophis sirtalis parietalis (Say)

Logan and Dry Lake, Cache County, Utah.

HYPSIGLENA OCHRORHYCHUS Cope

Castle Dale, Emery County; Chimney Rock Pass, and the west side of Utah Lake, Cedar Valley, Utah County; St. George and Zion National Park, Washington County, Utah.

Only a start has been made on the gathering of data on the distribution of this secretive little snake.

TRIMORPHODON LYROPHANES (Cope)

Two specimens collected by Dr. D. E. Beck and Mr. Arthur Paxman at St. George, Utah, were reported by Dr. Tanner in the Proceedings of the Utah Academy of Sciences, Arts and Letters, Vol. 12, 1935.

Since 1935 several specimens have been collected within Washington County. In April, 1938, Dr. V. M. Tanner collected two additional specimens at Saint George. One of these specimens is the largest yet taken within the state of Utah. It is 657 mm. in length.

On May 20, 1936, Dr. D. E. Beck found a large specimen on the road just north of the bridge in Zion National Park. The specimen was badly damaged, but not beyond the point of preservation. The specimen does not seem to differ, except for individual variations, from the specimens taken at St. George. The scale counts are: scale rows 22-22-15; ventrals 229; candals 69; candals 2; supra-labials 9-10; infra-labial 12-12; pre-oculars 3-2; post-oculars 3-4; loreal 2-2; temporals 3-5 on both sides; sex, female. Total length 611 mm.; tail length 102 mm. This specimen, in so far as the writer is aware, is the first to be taken within Zion National Park. Four specimens are in the Brigham Young University herpetological collection.

TANTILLA UTAHENSIS Blanchard

Schwitz Indian Reservation, Washington County, Utah.

At present we have six specimens from the type locality, some of which are paratype specimens.

CROTALUS VIRIDUS LUTOSUS (Klauber)

West side of Cedar Valley, Chimney Rock Pass and four miles west of Lehi, Utah County, Utah; Fairfield, Camas County, Idaho.

With the exception of the southeastern part of Utah, Carbon, Emery, Grand, San Juan and eastern parts of Wayne, Garfield, and Kane Counties in which the sub-species *decolar* is found, *lutosus* is found very commonly in other parts of Utah. Its main area of distribution in Utah is the Great Basin, although it does invade certain areas of the high plateaus.

Elevation records for this species are 8,900 at Bryce National

Park and about 8,000 at Mt. Timpanogos, in Utah County. It has been taken in the lower Sonoran zone along the Virgin River south of St. George and into Arizona.

CROTABUS MOLOSSUS MOLOSSUS (Baird and Girard)

Pine, Gila County, Arizona.

SUMMARY

1. Two new state records are reported: *Diadophis r. regalis* for Idaho, and *Rana p. pretiosa* for Arizona.

2. Three new records for Zion National Park are reported. This increases the known reptile species for the park to 24; 11 snakes and 13 lizards.

3. Notes on the general distribution within Utah and information of general interest are recorded for many of the species.

4. 320 specimens and 57 species are included in this report.

John E. Blazzard Contributes Mammal Collection

In 1928 Mr. John E. Blazzard began making a mammal collection which he continued until 1938. During this time 63 specimens (including skins and skulls) were prepared and labeled. This collection is represented by 36 species which were collected in Iron, Washington, Kane, Beaver, Garfield, Boxelder, and Cache Counties. The following are some of the interesting species in the collection: *Dipodomys merriami merriami* Mearns, (♂ ♀, St. George, Washington County, Utah, March 13, 1928); *D. ordii columbianus* (Merriam) (♂, Cedar City, Iron County, Utah, March 11, 1928); *D. ordii cupidineus* Goldman (♂ ♀, Kanab, Kane County, Utah, March 5, 1928); *D. microps celsus* Goldman (♂, Hurricane, Washington County, Utah, March 28, 1928); *Peromyscus boylii rowleyi* Allen (St. George, Washington County, Utah, March 13, 1928); and *Marmota flaviventris engelhardti* Allen (♂, Cedar Mountain, Iron County, Utah, June 2, 1929).

We want to thank Mr. Blazzard for this collection, as it adds a number of locality records to the collection of mammals in this University. Mr. Blazzard is an alumnus of the Brigham Young University. He was a member of the class of 1927 receiving a Bachelor of Science degree with a major in zoology.—V.M.T.

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